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DATE GROWERS' INSTITUTE

April 30, 1960



HELD IN
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The Date Growers' Institute is the official educational instrument of the date industry. Its goal is the dissemination of information on date growing, handling and marketing. This is its thirty-seventh year. Proceedings of each Institute have been published, and may be purchased in complete sets, or by separate copies. A full Index will be mailed on request. Direct all inquiries to

MRS. T. R. BROWN
Secretary-Treasurer
Route 2, Box 81
Thermal, California

DATE INSTITUTE COMMITTEE

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Thirty-Seventh Annual **DATE GROWERS' INSTITUTE**

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COACHELLA VALLEY

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VOLUME 37

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DEDICATION

By Leonhardt Swingle

Grower

I am certain that those of us who have been associated with the Date Institute for all these years are pleased, and somewhat surprised, that this is the 37th Annual Meeting, without fail or interruption. There have been a number of times it did not seem possible the Institute could continue much longer.

I have often thought there is one person who should be given credit, who was not a date grower or research worker, but without whose help and patience, the publication of the reports could not have been carried on without fail in the early years. This man was V. V. Green of the Coachella Valley Submarine. Someone worked out with him a method of printing the Institute papers, by which they were printed a paper at a time in the weekly Submarine and then when all had appeared they were combined in an annual report. Mr. Green probably thought they brought new subscribers to the paper and then he was paid for the printing at the end. I certainly hope that this was the case.

Two problems very soon appeared. First, some people could not see why the papers had to be published first in the Submarine, particularly Winn Wilson of the rival Date Palm. Several times it appeared as if the whole deal would blow up over this matter.

Another problem was that a long Date Institute, with many papers, would tie up too much of the Submarine's metal in articles that were all set up, waiting to be printed in the report. More than once he had to buy more metal.

This all came back to the financial problem that soon put in its unflinching appearance.

The Date Institute was financed in the beginning by aid from the Farm Bureau and Extension Service and with the patience of Mr. Green everything went along quite well until the bank holiday. There was enough money in the bank to pay that year's report when the bank closed and the Institute has never been quite even with the world since.

There were a number of years in the Thirties when there was considerable doubt whether there would be a Date Institute, or if so, if it could be published. Somehow it was done and not the least part of it was Mr. Green's patience in waiting for his money. I am happy to say he finally was paid off in full. As I look back after all these years, I do not quite see how it was done, but so it was.

When the first Date Diversion Program was started in the latter Thirties under the Coachella Valley Date Growers Association, they took charge of the Institute and carried it on until they passed out of the picture in the forties. We were then very fortunate in having Mr. and Mrs. T. R. Brown take the Institute under their wing and we all owe them a vote of thanks for what they have done. Without their care, it would have fallen on evil days, I very much fear. The financial problem is still with us and I leave it to Mr. Brown to explain how we hope to get it solved at this time.

INTERPLANTING A DATE GARDEN

By Thomas R. Brown

Grower

Many years ago, at one of the first Date Institutes, I heard Robbins Russell tell of the way the Arabs planted citrus trees between their date palms and in addition grew vegetables at the ground level.

The tree part of the program interested me and I believe that the grapefruit trees that I planted as an experiment about 30 years ago are among the oldest interplanted trees in the Valley.

Since that time I have interplanted all date acres that I own or control and have accumulated data that will be useful to other growers.

Some of the conclusions that I have developed are as follows:

1. The customary planting interval for date palms of 30 x 30 feet is too close for best results from a citrus production viewpoint. Citrus trees need more light than is available under these conditions. However: if palms are already planted at this spacing, it should not prohibit interplanting—it will mean reduced tonnage but not to a "no profit" point.

2. The quality of citrus fruit grown in partial shade is superior. A long record of top prizes at the National Orange Show will bear this out.

3. The quantity of citrus fruit grown interplanted will be from 40% to 60% of what the same trees would produce in the open. Cost per tree is also less, which partially compensates for low production.

4. Little or no apparent reduction in quantity of dates is observable where interplanting is practiced, but it is best to give the dates a head start rather than plant at the same time when using the 30 x 30 spacing.

5. When there is no rainfall during the harvest period there is no penalty as far as quality of dates is concerned. While it is difficult to prove, I assume that there is a little more loss from spoilage in an interplanted garden than in one without citrus. I am basing my assumption on the possibility of a higher level of humidity where citrus trees are located, but I have not checked this assumption with instruments.

6. Citrus varieties have different degrees of tolerance for shade. Grapefruit and tangerines do better than lemons.

7. Date palms protect citrus trees from frost to a high degree. At my home place the thermometer dropped

to 20 degrees but the loss of foliage on the citrus trees was confined to the outside rows during the cold years of 1949 and 50. As a substitute for smudge pots or wind machines the interplanting idea has much in its favor.

8. Wind damage and sunburn are greatly reduced in an interplanted garden.

9. While the 30 x 30 interval is admittedly too close for best results for citrus production, we have no proof of what will bring the best returns from a dollar basis. I am inclined to think that palms planted thirty feet apart in rows forty feet apart with a row of citrus trees fifteen feet apart between the date rows would give good results. Another method that has given good results at the Home Place is alternating double rows of dates and citrus—in other words two rows of citrus then two rows of dates. The rows are 25 feet apart; the palms 37½ feet apart in the row and staggered; the citrus trees 18¾ feet apart in the rows. The method of planting that will give the best results can only be determined by checking a series of test plots.

INTERPLANTING A DATE GARDEN WITH CITRUS

By D. H. Mitchel
Grower

The subject of interplanting a date garden with citrus was raised at the meeting of the Date Institute Program Committee in February. The Committee agreed that it was a topic of sufficient interest for a round table discussion. Since I had voiced an opinion as opposed to interplanting I have been asked to express my views here.

My experience with interplanting is limited to a five acre block of our original ten acres of dates planted 30x30 feet in 1933 and 1934. The north half planted in 1933 was interplanted with grapefruit in 1934, 15 feet from the date trees in the date row.

The citrus trees were removed in 1945, except for those in the outside rows and a few near the house. Our experience with interplanting led me to believe it did not pay for the following reasons:

1. PRODUCTION

The grapefruit produced 850 field boxes of fruit in 1942, the ninth year, an average of five boxes per tree. The remaining trees, since the date trees have grown taller and produce more shade, average three to four boxes per tree. Some of my neighbors produce 25 to 30 boxes per tree.

The production of dates was also less in the interplanted section than the south half of the garden. The number of bunches and the size of the fruit stems was affected.

Prolonged showers in September 1944 seriously affected the whole date crop and practically ruined the crop hanging over the citrus trees. The citrus leaves retained enough moisture after the rain to cause most of the dates to ferment. The south half of the planting was also damaged but not as seriously as the north half. We became convinced that interplanting did not pay and removed most of the citrus trees.

2. CULTURAL PROBLEMS EXPERIENCED

a. Citrus roots are not as deep as date roots and this factor affected both crops. We have always fertilized heavily and the shallow citrus roots were "first at the table." The date roots, being deeper than those of the grapefruit trees, got what fertilizer was left as it filtered down to them.

b. Irrigation experiments at the Indio Date Field Station have shown that the annual amount of water used is more important than the amount per week or month, particularly in

soils of high water-holding capacity. If the subsoil is thoroughly wet the crop is not affected if the surface is permitted to be fairly dry during the late summer or harvest season. This is important in that hazardous time when showers may be expected. However, citrus trees with their shallow root system, growing over thirsty date roots, need frequent irrigation or the trees will wilt and the crop will suffer.

c. Interplanting increases the cost and decreases the efficiency of cultural practices. Tractoring problems are multiplied, and permanent borders, with the salt concentration, are a problem with interplanting. Extension ladders are hard to handle at any time and become a real problem with citrus limbs blocking the row.

The only reason I can see for growing either dates or citrus is to make a profit on operations. To do that one must grow the greatest quantity of the highest quality fruit possible. Interplanting or intercropping while the date palms are growing up will help to balance the budget, but a standard planting of 30x30 feet for mature date palms properly fertilized and watered does not permit enough sunshine to filter through to nourish another crop.

INTERPLANTING

By Leonhardt Swingle
Grower

Let me say at the start, that I approach interplanting from the viewpoint of the date grower. I have a few citrus trees under dates, but I can speak with no authority as a citrus grower. Also, let me say that in talking of interplanting, I am speaking of dates planted 30 by 30 with citrus between. This is what is commonly known as interplanting in the Coachella Valley at this time. If we recall Mr. Nixon's pictures, a few years back, of Hasa, he showed plantings of dates around an open area with various crops planted in this enclosed area. A method of alternate dates and citrus, or partial planting of each, may come in this locality, but interplanting at this time means a regular planting of dates with citrus between or under them.

We take care of a number of date gardens interplanted to grapefruit and in one garden we have a great deal of trouble with palms blowing over. Possibly there is no connection as dates blow over in a number of places, but we are inclined to think

that the continued and heavy irrigation necessary for the two crops aggravates this trouble. When a big palm goes over in a garden with mature grapefruit trees, it makes quite a mess.

We find all tree work on the dates to be more expensive. Carrying a big ladder through a grove is hard enough, but it is doubly hard when citrus trees have to be dodged. The slow-down makes work such as pollination and thinning and tying-down cost about a third more. The application of sulphur and malathion may be much more difficult and again it may be not much more difficult than gardens without citrus. The individual garden and its particular layout is the determining factor, but in any case it is more expensive in interplanted gardens.

Picking does not seem to be more difficult, but of course getting the fruit out usually means an extra man or two. This part of the operation is not a great factor in added expense, but altogether it just costs

more to grow dates in an interplanted garden.

The quality of the date crop is just not quite as good. There is apt to be more shrivel and smaller size, also more drop. I am speaking now of the present years which have been drier than usual, and of which it would seem the added humidity would be a benefit. We can look back on years in which it rained or the humidity was very high and the dates suffered badly. I have seen bunches of dates hanging in citrus that were a total loss and some whole date crops that were just about ruined by the added humidity from the citrus. We have not had a wet year for a long time and perhaps they will not come again, but if they do, it will be hard on dates in citrus.

We can summarize our opinion by saying that we do not believe the citrus fruit picked in an interplanted garden will compensate for the lowering of quality and quantity of the dates, and the increased cost of growing the date crop under such conditions.

A REVIEW OF THE DATE ADMINISTRATIVE COMMITTEE'S RESEARCH PROGRAM

By Billy J. Peightal, Mgr.

Today the Committee's research program will be reviewed and a film shown entitled "Building Food Sales Through Better Merchandising." Neither the program nor the film touch on production research, but they are presented because it is believed growers are also interested in research matters outside of that subject. In fact, problems facing date growers today are not primarily those of production. Rather, they are those related to the matter of selling all of that which is produced, consistent, of course, with reasonable returns. There are two parts to this problem: one is a matter of price; the other is the need for the industry to sell increasing quantities of dates. Every grower is aware of the first part of the problem, but increasing attention must be given to the second. One needs only to look at the figures showing the amount of dates held by handlers to become aware of this. "Building Food Sales" is not academic, it is necessary for survival.

The research phase of the Marketing Order, like the operational phase, is directed toward the solution of this fundamental problem. Therefore, it will briefly be reviewed in order to permit you to become more familiar with it, and to encourage your thinking along the lines related to that problem.

OBJECTIVE CROP ESTIMATES. The objective crop estimating project was initiated last year to determine whether more reliable estimates of total crop size, grade, and distribution of date sizes can be determined in advance of harvest. The success of any marketing program and of marketing decisions depends, on having full and accurate information with respect to supply conditions, and it is therefore essential to have reliable estimates. Current crop estimates are determined from the aggregate of handler estimates of the quantity of dates each expects to handle, while objective estimates will be determined through statistical procedure and derived from the relationship of bunch counts, strand counts, and date counts made on a selected basis on selected trees throughout the producing area.

PACKING HOUSE OPERATIONS. With the objective of aiding packing houses to operate at lower costs, the Committee sponsored two projects relating to packinghouse operations. One project was the study of packinghouse work methods to determine whether facilities currently

in use could be used more efficiently, and to ascertain those operations which could be improved through development of new packing and handling equipment. The results of this study should be published soon.

The other project related directly to packinghouse operations is the one directed toward the development of a moisture determination system incorporating a device which electronically will measure the moisture content of dates. Such a system should lead to an improvement in packaged dates by enabling greater uniformity of moisture to be achieved. Progress is being made in development of the system, although not as rapid as desired.

QUALITY. Considerations of quality are given a place of major importance by the Committee since it realizes that dates sold consumers must have good flavor, good texture, and an attractive appearance to encourage repeat purchases. Growers, too, need to consider strongly this matter of quality, for it is to their long term benefit that only dates with good eating characteristics be grown and sold. This should be apparent, since dates seem to have little to offer other than taste and eye appeal.

Underlying all of the quality work is the chemical composition study being conducted by Dr. Vincent Maier at the USDA Fruit and Vegetable Chemistry Laboratory in Pasadena. It is his purpose to provide information with respect to the chemistry of the date, and to ascertain the changes associated with deterioration in order that corrective measures may be devised. This work, together with the storage investigations conducted by Dr. Rygg, will form the basis for all future endeavor in the area of quality maintenance and improvement.

Two projects concerned with quality considerations were initiated this year—one pertaining to an evaluation and study of hydration practices and principles, and the other relating to the preservation of high moisture dates in packages. With reference to the hydration study, the entire matter will be investigated at the USDA Pasadena laboratory and ultimately, optimum hydrating conditions will be established. Once this is done, hydration can be a controlled process with predetermined results rather than one in which operator judgment plays such an important part with resulting variations in end product.

Relative to the preservation of high moisture dates in packages, the Food

Additives Amendment prescribes that all food additives be proven safe through acceptable scientific procedure by March 6, 1960. It therefore was necessary to establish the safety of additives used in date packaging and the Committee initiated a research project for this purpose. It is anticipated the project will extend over a three year period, but results already obtained were used to secure approval from the Food and Drug Administration for continued use of the additives for an additional year's time.

SALES. The Committee's research program also covers those subjects of direct assistance to the sales effort. One of the projects it obtained measured and evaluated the sales effectiveness of selected methods of in-store merchandising. The findings of this study greatly have aided the sales people. Another project consisted of a survey which ascertained housewives attitudes, opinions and uses of dates, and this, too, has been invaluable to sales planning and merchandising.

In order to provide additional items and increase the means by which dates may be sold, the Committee initiated a project for the purpose of developing and improving date products. Most notable of the new products is a chocolate coated candy bar which is a very acceptable product with a large potential, and a low moisture but soft textured date piece which can be incorporated in dry cereals without gaining or losing moisture. This development is a major technological advancement, and it resulted directly from the chemical composition studies.

The latest endeavor of the Committee pointed toward increasing sales is directing and coordinating industry efforts of participating in food fairs held in foreign countries. This is being done in cooperation with the U.S. Department of Agriculture. The fairs this year will be held in London and in Munich during the latter part of summer. Industry participation will consist of displaying packaged dates in a manner similar to super market displays, with additional material furnished for buyer sampling. Through such means as this, it is hoped that foreign buyer interest in dates will be stimulated and that handlers will increase their foreign trade.

In what areas of interest will the Committee attempt to obtain future research? The most obvious areas

are those of tree work mechanization, particularly harvesting, and of bulk fruit handling in the field and in the packing house. Since it is believed the labor now available for field operations will not be available at reasonable cost within a few years, if available at all, the industry must prepare for mechanization. This might necessitate such practices as picking only once with packinghouse processing, substantially improved over present methods, given the responsibility of manufacturing natural dates, and any other type date desired. In any event, considerable investigation of the problem will be required.

The various research projects included in the Committee's research

program have been mentioned in this meeting of growers primarily to encourage thinking on matters in addition to those associated with production, because it is believed the major problems of the industry are in these other areas. To further encourage thinking in the other subject areas, it is proposed that some of those investigating them be invited to speak in subsequent meetings of the Date Grower's Institute. Mr. Parr, who is on the program to discuss objective crop estimates, is one of those. The procedures he will outline are utilized by the largest fruit industries and they spend thousands of dollars to obtain objective crop estimates mainly to improve or develop the best mar-

keting program possible. It is suggested that engineers who have developed mechanical harvesting equipment for other industries be invited, that this equipment be shown, that bulk handling techniques be demonstrated, and that research programs carried on by some of the dried fruit industries be given consideration.

The film "Building Food Sales Through Better Merchandising," which in part portrays the results of merchandising tests reported in the 1958 annual report of the Date Growers' Institute, will be shown now. The actual tests resulted from one of the research projects sponsored by the Committee.

REPORT OF THE FIRST INTERNATIONAL TECHNICAL MEETING ON DATE PRODUCTION AND PROCESSING

By Roy W. Nixon

Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture
U. S. Date Field Station, Indio, California

The First International Technical Meeting on Date Production and Processing was held at Tripoli, Libya, December 5 to 11, 1959, under the sponsorship of the Food and Agriculture Organization of the United Nations. The International Cooperation Administration ("Point 4") made it possible for me to attend as a representative of the United States.

No formal papers were read at the meeting. Instead, two large background papers covering the subject matter in considerable detail were prepared by specialists of F.A.O. and mimeographed copies were given to all delegates before the first session. In addition 18 papers submitted by delegates and others who have worked on dates were also mimeographed and distributed in advance. When a particular subject was brought up, a delegate who had prepared a paper on the topic was asked to comment first. This was followed by open discussion in which there was usually general and lively participation.

Each session dealing with date production was opened by F. P. Pansiot, Horticulture Specialist, Plant Production and Protection Division, F.A.O., who outlined the topic or topics. Similarly, A. Aten, Rural Industries Specialist, Land and Water Development Division, F.A.O., opened the sessions dealing with date processing. These two men were largely responsible for the over-all planning of the conference, while V. H. W. Dowson, F.A.O. date specialist in Libya, took care of local arrangements.

Except for introductory addresses in Arabic by officials of the Libyan Government, English was the lan-

guage of the presiding officials, but some of the discussions were in French. There were interpreters to translate from one language to the other. I will not attempt to cover the subject matter presented in the background papers, in which the whole range of date culture was included. In fact, F.A.O. intends to enlarge and perfect this material into a manual on date culture. I will try only to give a brief resume of the discussions which aroused most interest and to which most time was devoted. No new or startling scientific discoveries were reported, but the discussions brought to light many unrecorded experiences and little-known facts which provide a better understanding of the practices and problems of date culture in different parts of the world.

STATISTICS

At the opening session some statistics concerning world date production were given. According to F.A.O. estimates there are about 87 million date palms in the world, with a total production of 1,200,000 metric tons. The principal date-producing countries and their estimated production in metric tons are Iraq 330,000; United Arab Republic, Southern Region (Egypt) 170,000; Iran 150,000; Saudi Arabia 100,000; and Algeria 96,000. Dates are also produced in large quantities in Pakistan, Bahrain, Oman, Aden, Sudan, Libya, Tunisia, Morocco, French Equatorial Africa, French West Africa, Spain, and United States of America and in small quantities in a few other countries. Only five countries export large quantities of

dates; these, with their annual exports in metric tons, are Iraq 240,000; Iran 29,000; Algeria 17,000; Sudan 6,000; and Tunisia 3,000.

Yields per palm are low, probably not over 20 kilograms, but in every country large numbers of palms are unirrigated or seriously neglected and produce still less, whereas the production of well-cared-for gardens would be much higher. Yields per palm should be considered in relation to density of planting as yields decrease with closer spacing.

OFFSHOOTS

Of all the production subjects discussed most time was devoted to offshoots and the establishment of date palms. Opinions vary in different countries as to whether it is better to take offshoots from well-irrigated palms or from palms in somewhat dry soil. In Iraq the highest-priced offshoots are said to be those from well-watered palms on the river bank, but in other countries (Egypt, Libya, and Tunisia) offshoots from palms in drier places are preferred. In Mauritania at the Kankossa experiment station no difference has been found in the survival of offshoots from irrigated and unirrigated palms. In Tunisia it was said that date growers traditionally have dried out offshoots for a few days to a week before planting. On the other hand, in Sahara (formerly southern Algeria) experience in planting large numbers of offshoots has disproved the idea that drying favors survival. In Libya an experiment was made with offshoots that had been considerably delayed in shipment from one part

of the country to another. Most of them were planted in nurseries and irrigated daily, but some, chosen at random, were soaked 10 to 18 days in water 8 inches deep and subsequently planted in nurseries with the others. Nearly all the offshoots which had been soaked died later.

In most countries medium-sized offshoots seem to be preferred to either small ones or very large ones, but the discussions did not bring out just what was meant in terms of weight or dimensions. It was agreed that the offshoot should have some roots before it is cut.

With regard to position on the trunk, it was reported that at Kankossa, Mauritania, there has been no significant difference in mortality between high and low-placed offshoots. However, the same station reported that high offshoots tend to produce abnormal palms and are not generally used for propagation.

The necessity for care in the cutting of offshoots was stressed by several delegates. It was claimed by some that in Tunisia and Libya the survival of offshoots was better when a small portion of tissue from the mother palm was left attached. However, the high percentage of survival without it when cutting is carefully done raises the question as to whether the tissue from the mother palm is of any value and suggests that this idea might have originated because offshoots with this tissue were more carefully cut and less injured than those without it.

The importance of protecting newly planted offshoots by wrapping at time of planting was emphasized by a number of delegates. That the wrapping should be somewhat porous, at least not air-tight, was demonstrated by experiments at El Arfiane, Sahara, where the protection of offshoots by polyethylene bags resulted in rot.

All agreed that frequent light watering—daily in very light soils—is important in survival.

Some experiments in Morocco to promote the rooting of offshoots with hormones were mentioned but further work is needed in this field.

The best time of planting offshoots varies with seasonal conditions in different countries. In most places spring is favored, but in some regions other times may be preferred either because of better weather conditions or because more water is available.

The mortality of newly planted offshoots in Sahara and Somaliland was said to increase as the salt content of the soil increased. Offshoots from palms growing in saline soil have been found to survive better in such soil than those from relatively non-saline soil.

PALM SPACING

Density of planting was discussed and it was brought out that spacing of palms is conditioned by climate and variety. Along the Libyan coast east of Tripoli the spacing of palms is wide to counteract the ill effects of low summer temperatures and high humidity. Although uniformity is lacking, palms in this area are often planted 10 meters (33 feet) or more apart in rows separated 30 meters (98 feet) or more.

At Kankossa, Mauritania, spacing trials are being made with date palms planted 5 to 10 meters (16-33 feet) apart. A spacing of 7 x 7 meters (23 feet) is currently being recommended for that region with somewhat closer spacing where the climate is drier and wider where it is more humid. When palms are closely planted the fruit is said to have a lower sugar content and to require longer for drying.

METAXENIA

The possibility of making use of metaxenia, or the direct effect of pollen on the fruit, to obtain beneficial changes in time of ripening was pointed out. Dates are grown along the Mediterranean coast of Libya and Tunisia and in other places where there is not enough heat to ripen late varieties and even the earliest varieties are often damaged by fall rains which increase in amount and frequency as the season advances. Earlier ripening would be very beneficial under these conditions. Research in California justifies the belief that this earlier ripening may be obtained by the use of different pollen. Monsieur A. Monciero, in charge of the date work in Sahara, reported that 2 weeks' earlier ripening had been obtained at the El Arfiane Station with Fard No. 4 pollen sent from the U. S. Date Field Station, Indio, California. Whether this acceleration in time of ripening can be obtained in any particular locality can be determined only by experimental tests.

VARIETY STUDY, SELECTION AND BREEDING

The need for variety study, selection, and breeding was emphasized. The breeding of disease-resistant varieties is probably the only way that date culture can be re-established over much of Morocco, where the bayoud disease has almost wiped it out. The Libyan Government has started a varietal testing station near Tripoli, where offshoots of about 70 varieties have recently been planted. This station was visited as part of an all-day field trip on the last day after the end of the formal sessions.

MISCELLANEOUS REPORTS

There were some miscellaneous reports that may be of interest. In Mauritania sorghum has been found

to be a satisfactory cover crop. It was said to be grown easily with only one or two irrigations. In September when it is 50 to 60 centimeters (24-28 inches) high it is plowed under and gives 7 to 8 metric tons of green manure per hectare (2½ acres). The seed is planted in July at the rate of 20 to 25 kilograms per hectare (18-22 pounds per acre).

Sprays have not been very satisfactory in experiments to control parlatoria date scale. Biological control was said to be better.

A rhinoceros beetle (*Oryctes boas*) was reported as having attacked and mostly destroyed about 15 percent of the date palms in the vicinity of Hofuf, Saudi Arabia. In Somalia the same pest was said to have killed about 10 percent of the date palms.

DATE PROCESSING

The sessions on date processing were largely taken up with a discussion of the work that has been done in this field in Libya by F.A.O. A date packinghouse of modern design has been put up in Tripoli under the direction of F.A.O.'s date expert, V. H. W. Dowson, and is now being operated by the Libyan Government. F.A.O.'s activity during the last 2 years has been chiefly concerned with by-products, which are especially important because of the large tonnage of low-grade fruit produced. Experiments are being carried on with date paste, which it is hoped may be combined with some protein-rich material to provide an appetizing and attractive nutritionally balanced product.

A refined technique has been developed for the production of date syrup and a small pilot plant was recently installed to manufacture it. The various steps in the process are (1) cutting the pitted dates into pieces of suitable size for extraction; (2) extraction with warm water; (3) sterilization by boiling and adjustment of degree of acidity; (4) filtering; (5) evaporation in a vacuum; and (6) packing and storage. The delegates visited the pilot plant and its operation was explained by W. H. Barreveld, F.A.O. date processing expert in Libya. I have never tasted a better date syrup. There is probably a considerable market for date syrup in the Middle East, as Arabs are very fond of it. It is questionable whether date syrup can compete in the West with maple, cane, and various blended syrups already on the market.

RECOMMENDATIONS

As a result of the discussions, the delegates to the First International Technical Meeting on Date Production and Processing made the following unanimous recommendations:

I. Recognizing the need for the promotion of closer international co-operation in date research, and for

better contacts and exchanges of information between research stations and date workers in general, it is requested that the Director-General of the Food and Agriculture Organization of the United Nations:

1. assist the date-growing countries in interchanging technical knowledge by means of visits and exchange of personnel and information among the research centers of the different date-growing areas, and by publishing annually a mimeographed news letter which will summarize observations made by date specialists.
2. prepare and issue publications on "The Improvement of Date Palm Growing," and on "Date Processing and Utilization of By-Products," and also to publish a world list of research stations and persons working on date palm investigations.
3. grant scholarships and fellowships to date-producing countries for training in modern date production and processing methods.
4. arrange for the publication of uniform color standards and names for use by research workers in different countries. (Republication of Ridgway's "Color Standards and Nomenclature" was suggested.)

II. *Recognizing* the great possibilities offered by selection and breeding work for improvement of date growing, particularly in the marginal areas, and *considering* the lack of sufficient information on various aspects of date culture such as causes of mortality and factors affecting the establishment of offshoots, nutrition and water requirements, and ecological requirements, particularly as re-

gards temperature and atmospheric humidity conditions, it is recommended that the governments of the date-growing countries:

1. undertake studies on the selection of male palms and their metaxenial action on local varieties, particularly on hastening of ripening and the improvement of fruit characters.
2. undertake studies on the genetics of the date palm.
3. establish well-equipped and staffed research stations and more collections of date varieties.
4. undertake more research on the propagation and establishment of offshoots, on the use of organic and inorganic fertilizers, on soil and water requirements, on salt tolerance, and on temperature and atmospheric humidity requirements.
5. study the influence of intercropping (annual and perennial crops) on date palms and vice versa.
6. strengthen the extension and training facilities so that the results of research work can be better disseminated to date growers.

III. *Considering* the great damage caused by certain pests and diseases to the date groves of various countries, particularly by the "bayoud" disease (*Fusarium albedinis*), and *considering* also the difficulty of controlling scale insects in many date groves, particularly the white scale (*Parlatoria blanchardi*) by the usual chemical spraying methods, which moreover are in danger of upsetting the biological equilibrium, and *considering* the promises of biological control in this case, and *recognizing* that more drastic plant quarantine measures have to be enforced in order to avoid the introduction of danger-

ous pests and diseases in uninfected areas, it is recommended that the governments of the date-producing countries:

1. undertake more research work on control methods, particularly as regards the bayoud disease and especially in the selection of disease-resistant varieties.
2. enforce strong plant quarantine measures to prevent the introduction of this disease in regions so far uninfected:
 - (a) by prohibiting the transport from infected areas of all date palm products (offshoots, wood, leaves, etc.) and all objects manufactured from parts of the palm.
 - (b) by warning the phytosanitary services of the date-producing countries against the dangers of introducing diseased offshoots and products manufactured from parts of palms originating in regions recognized as, or suspected of, being infected by the disease, and by recommending that in every case of the importation of any such products or offshoots a certificate authorizing the importation should be issued by the phytosanitary services of the importing country.
3. study the possibility of establishing or developing biological control of scale insect parasites of the date palm and include this subject in the program of work of the research stations in order to obtain information on the various predators and to breed the most active species so as to arrange for their distribution on a large scale in infected regions.

INFLUENCE OF SUMMER OR FALL DROUGHT ON HARD END AND IMMATURE SHATTER OF HALAWY DATES

By J. R. Furr and W. W. Armstrong, Jr.

Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture
U. S. Date Field Station, Indio, California

All varieties of dates should be liberally supplied with soil moisture in spring and early summer, the period when the fruit is green and is rapidly increasing in size (1, 2, 8, 9, 10). In irrigation experiments with the varieties Deglet Noor and Khadrawy it was found that after the fruit had attained full size, moderate water shortages during maturing and ripening of the fruit in late summer and fall resulted in little or no injury to the fruit (4, 5, 6, 7), and it has been said that some varieties seem to improve in quality with a low soil-moisture content during the ripening period (1). To reduce rain damage and hasten curing of the fruit or to facilitate harvesting opera-

tions it is sometimes desirable to reduce or withhold irrigation water during the period of fruit maturing and ripening. The variety Halawy, however, has long been known to be subject to shrivel and hard end, fruit disorders that are thought to be aggravated by low humidity and drought. Therefore, some writers have recommended that Halawy trees be irrigated frequently throughout the ripening period (10) or that more water be applied during ripening than seems necessary for other varieties (8).

The present investigation was conducted to determine the influence of periods of moderate water shortage during summer and fall on the quality

of Halawy fruit, especially the effect of lowering the soil-moisture supply during the khalal and ripening stages of fruit development.

MATERIALS AND METHODS

The trees used in this experiment were planted on soil classed as Indio loam and were 14 years old in 1957 when this experiment was started. The top 4 or 5 feet of this soil is somewhat stratified material that was judged from inspection of samples taken with a soil tube to range from very fine sandy loam to silty clay. From a depth of 4 or 5 feet to about 15 feet it is sharply stratified material, mostly fine sand interspersed with layers of varying thickness, ranging

in texture from silty sand to silty clay. This soil seems to be well suited to the production of Halawy dates.

The small block of trees available for this experiment was divided by permanent borders into 9 small irrigation plots, each with a single record tree, and separated from adjoining plots by a single border row. The irrigation treatments, each replicated 3 times, were as follows:

- (1) W (wet), irrigation about every 2 weeks from spring to late fall; about 10 feet of water per year.
- (2) J (June and July dry), irrigation the same as W, except that water was withheld in June and July.
- (3) A (August and Sept. dry), irrigation the same as W, except that water was withheld from early August to the completion of harvest in October.

This time schedule for withholding irrigation water was only approximate and was designed to subject the trees in the J and A plots to moderate drought in late July and late September, respectively.

Actually, the J plots were allowed to dry from June 1 until the growth rate of immature leaves was reduced to about 70 percent of that of leaves on trees in the wet plots. It was planned also to allow the growth rate of leaves in the A plots to drop to 70 percent of that in the W plots before resuming application of water, but in practice fruit harvest was completed each year before such a growth reduction was attained and consequently water was applied soon after harvest was finished in October.

Gypsum resistance blocks were installed in the soil of the J and A plots at 1-foot intervals from a depth of 1 to 6 feet and at depths of 8 and 15 feet. In summer and fall the resistance readings obtained periodically from these blocks served as a guide to the moisture conditions in the soil of the J and A plots during drying and re-wetting. The leaf-growth rate of each record tree was determined by observing the distance through which a steel measuring tape attached by a fine wire to the rachis of an immature leaf was drawn past a reference point during the periods of one to several weeks. The fruit produced by the record trees was harvested in 3 picks each year of the experiment (1957 and 1958), and immediately after each pick it was graded to determine the proportions of fruit in the following categories: (1) normal, (2) hard end and (3) immature shatter or shrivel. Normal fruit that could be marketed as whole fruit and that had apparently not been seriously affected by drought was separated from the fruit that was abnormal and may have been injured by drought. Ripe fruit with hard,

usually whitish, tissue at the base was classed as having hard end. Khalal or immature, partly soft fruit, and immature shriveled fruit that fell off the bunches during the picking operations was all classed as immature shatter. Some poor or damaged fruits of other sorts were classed as culls. The trees in this experiment produced very little tree-ripe fruit of the usual shriveled-and-dry type often observed on Halawy palms under unfavorable conditions. Nearly all the ripe fruit except that affected by hard end was soft and of high moisture content at harvest.

RESULTS

In 1957 water was withheld from the J plots from May 29 to August 6 and from the A plots from August 8 to October 17. The electrical resist-

Table 2. The influence of drought on the average daily rate of elongation of Halawy date leaves (in centimeters), 1957 and 1958.

Year and Period	Treatment		
	W	J	A
1957			
6/4 - 6/23 ¹	2.6	2.7	2.5
6/24 - 7/29	3.7	2.8	3.8
7/30 - 8/4	3.8	2.4	3.8
8/5 - 9/9	4.5	4.4	4.7
9/10 - 9/19	4.3	4.9	4.1
9/20 - 10/6	4.3	4.3	4.3
10/7 - 10/14	3.5	4.2	3.3
1958	W	J	A
6/16 - 6/30	3.3	3.5	3.5
7/1 - 7/13	3.7	3.4	4.0
7/14 - 7/31	4.1	3.0	4.3
8/1 - 8/10	3.8	3.6	4.0
8/11 - 8/19	4.6	4.5	4.4
8/20 - 8/25	4.4	5.2	4.4
8/26 - 9/7	5.0	5.3	4.6
9/8 - 9/15	4.1	4.7	4.1
9/16 - 9/28	4.3	4.9	4.3
9/29 - 10/1	4.1	5.0	4.2

¹Dates are inclusive.

Table 1. Electrical resistance of gypsum moisture blocks (thousands of ohms) in soil of the principal root zone of Halawy date palms under treatments J and A in 1957.

Treatment and Tree	Soil depth (feet)	Date						
		June 24	July 30	Aug. 5	Sept. 10	Sept. 23	Oct. 8	Nov. 27
J ¹ 6-1	1	21.0	96.0	110.0	0.4	0.7	0.7	0.8
	2	5.3	42.0	45.0	0.4	0.6	0.6	0.7
	3	1.1	19.0	21.0	0.4	0.4	0.5	0.6
	4	0.3	9.0	11.0	0.3	0.3	0.4	0.5
A ² 4-4	1	0.9	0.7	1.9	58.0	120.0	200.0	0.9
	2	0.4	0.5	0.7	11.0	28.0	33.0	0.8
	3	0.3	0.4	0.4	0.4	1.2	2.8	0.5
	4	0.2	0.3	0.3	0.3	0.3	0.3	0.4

¹J plots were irrigated August 6.

²A plots were irrigated October 17.

ance readings of gypsum moisture blocks in the top 4 feet of soil at two locations (under tree 1-9 in a J plot and under tree 4-4 in an A plot) illustrate the soil-moisture conditions in the drought plots during summer and fall (Table 1). The resistance readings in these plots suggest that only the top foot of soil reached the wilting point, but that in both plots, shortly before water applications were resumed, water stress was fairly high in the top 3 or 4 feet of soil, the principal root zone of these trees. During the period July 30 to August 4, the average daily rate of leaf elongation of the trees in the J plots was reduced to 2.4 centimeters per day, about 62 per cent of the growth rate of leaves on the trees in the wet plots (Table 2). Resistance readings of soil-moisture blocks in the A plots showed that near the end of the drought period to which these plots were subjected in 1957 the available moisture in the top 3 feet of soil was low. Nevertheless, the leaf-growth rate was nearly the same as that in the wet plots (Table 2).

During the period of drought to which trees of the J plots were subjected there was no evidence that the fruits were affected by the water

shortage that reduced the leaf growth. At harvest, however the effect of drought that had reduced leaf growth during the last 2 weeks of July and the first week of August was quite apparent. In the first pick in the J plots, September 10, the amount of fruit that dropped off the bunches as they were handled in the picking operation was relatively great. Most of the fruit that dropped was either in the khalal stage or was partly ripe. Much of the fruit graded as immature shatter fell onto the picking trays in the first pick. The classification of the fruit of all three picks shows that the incidence of hard end of trees under the J treatment was significantly greater than on trees under the W treatment and that the incidence of immature shatter on the trees under the J treatment was significantly greater than on trees under the other two treatments (Table 3). The amounts of fruit affected by hard end and immature shatter on trees under the A treatment in 1957 were not significantly different from those on trees under the W treatment.

In 1958 the plots under the J and A treatments were subjected to somewhat less severe drought than in 1957. Water was withheld in 1958

from the J plots from May 29 to August 1 and from the A plots from July 24 to October 2. Water was applied to the trees in the J plots when the average growth rate of their leaves was reduced to 73 percent of that of trees in the wet plots. Though

Table 3. The relation of drought to the incidence of hard end and immature shatter of Halawy date fruit.

Year and treatment	Grades—Pounds per Tree			
	Normal	Hard end	Immature shatter	Culls
1957				
W	120	5.7b ¹	13.0b ²	0.4
J	144	30.5a	55.0a	0.4
A	198	16.2ab	7.0b	0.6
1958				
W	156	8.2	13.4	7.8
J	144	22.6	32.6	7.1
A	177	10.1	17.9	13.9

¹Means followed by letter **a** are significantly different from those not followed by **a** at odds of 19:1; means followed by letter **b** are significantly different from those not followed by **b**.

²The mean followed by letter **a** is significantly different from those followed by the letter **b** at odds of 99:1.

the drought periods were about as long in 1958 as in 1957, the leaf-growth rates indicated that the trees suffered less severe water deficits in 1958 than in 1957.

In 1958 somewhat more fruit was affected by hard end and immature shatter on trees in the drought plots than on trees that suffered no water shortage, but the differences were not statistically significant. The treatments in neither year significantly affected the total yields of trees.

DISCUSSION AND CONCLUSIONS

Withholding water from the trees in the J plots for about 11 weeks in the summer of 1957 when the fruit was green and increasing rapidly in size resulted in serious injury to the fruit which became apparent at harvest. This treatment, as compared with maintaining an ample water supply all summer, resulted in a marked increase in shrivel and shatter of immature fruit and in a significant increase of fruit affected by hard end. Withholding water from trees in the A plots for approximately 8 weeks prior to completion of harvest on October 7, 1957, did not result in a significant increase in the amount of fruit affected by hard end and immature shatter. Drought in September and early October probably had a less harmful effect than in mid-summer, both because of the cooler weather and because of the more advanced stage of fruit development; that is, during this period the fruit had completely passed the green stage of rapid growth and was in the late khalal stage or was actually ripening.

In 1958 drought treatments of about the same duration as in 1957

did not significantly affect the incidence of hard end and shatter. The reduced effect of drought in 1958 may have resulted from some adjustment of the trees to drought conditions, such as was observed during an irrigation experiment with Khadrawy dates (3), in which trees were less affected by drought after being subjected to several cycles of drying and rewetting than during the first cycle. At any rate, the leaf-growth rates in the two years indicate that water stress in 1958 was somewhat less severe than in 1957, and this decreased stress may largely account for the decreased damage to the fruit by drought in 1958.

How severe water shortage must be to induce the production of hard end, immature shrivel or immature shatter of Halawy fruit is not clear from these results. It seems likely, however, that not only are severity and duration of water stress in the tree important but that the stage of development of the fruit is a particularly important factor in its susceptibility to injury from drought. Since the appearance of the green fruit in the J plots in July 1957 did not reveal drought injury, it seems likely that fruit disorders observed at harvest have sometimes been attributed to water shortage during maturing and ripening, when actually the damage resulted from water shortage when the fruit was green and growing.

The results obtained in this experiment indicate that fruit of the Halawy, like that of Deglet Noor or Khadrawy, is much more sensitive to drought injury in mid-summer during the green stage than in later summer and fall during maturing and ripening. In fact, subjecting the trees to moderately severe drying of the soil during maturing and ripening of the fruit had little apparent deleterious effect. In commercial practice it is unlikely that water would be deliberately withheld from the trees for two months or more in late summer and early fall, nor does such a practice seem advisable with the variety Halawy, which may be more sensitive to injury from drought than other common varieties such as Khadrawy and Deglet Noor. The results reported in this paper, however, do not indicate a need for unusual frequency of irrigation or for the application of unusually large amounts of water to Halawy palms during maturing and ripening of the fruit. On heavy soils (such as the Indio series) on which Halawy is usually grown it seems likely that the annual application of 10 feet of water of as good quality as that from the All American Canal, applied during the growing season at about fortnightly intervals, would provide adequate water

for Halawy palms, as it does for Khadrawy and Deglet Noor on these same soils.

The most striking feature of this investigation was the evident relation between water stress during the green, growing stage of the fruit in 1957 and the subsequent development of the fruit disorders khalal shrivel and immature shatter, which caused heavy losses during the first pick in September.

SUMMARY

In 1957 and 1958, some Halawy date palms were subjected to moderate drought in June and July (treatment J), others in August and September (treatment A), and still others were given ample water all year (control wet treatment, W). Soil-moisture conditions were determined from resistance readings of gypsum moisture blocks in the drought plots, and leaf-growth rates of trees under the different moisture treatments were used as indicators of the severity of stress for water in the trees. In 1957 the leaf-growth rate of trees under treatment J was reduced to 63 percent of that of trees under treatment W. This reduction resulted in heavy losses of fruit at harvest because of a large increase in fruit affected by the disorders hard end, khalal shrivel and immature shatter. The soil of plots under treatment A became about as dry during September and October as had that of plots under treatment J in July and August, but trees showed less stress because of lower temperatures and higher humidity in the fall. The amounts of fruit affected by hard end and immature shatter on trees under treatment A were not significantly different from those under treatment W. In 1958 the drought treatments resulted in less severe water stress in the trees than in 1957; and though the incidence of hard end and immature shatter was higher in 1958 under treatments J and A than under treatment W, the differences were not statistically significant.

Fruit injury resulting from drought was much greater in trees subjected to drought in midsummer, when temperatures were high and fruit was green and growing, than in trees subjected to about as severe drought in the fall, when temperatures were lower and fruit was maturing and ripening. Apparently, duration and severity of drought, as well as weather conditions and stage of fruit development at the time of drought, are factors in the development of hard end and immature shrivel of Halawy fruit.

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AN UNUSUAL DISORDER OF BARHEE DATE PALMS

By Ellis F. Darley¹, Roy W. Nixon², and Wesley D. Wilbur¹

During the 1958 fruit season, the authors' attention was called to an unusual bending of the tops of Barhee palms on the Russel-Alexander ranch east of Indio, California. The center leaves of the tops of affected trees were characteristically bent to the south or southeast (Fig. 1). The tops of a few of the trees were bent to the east or west, but none were bent to the north. The degree of bending varied from a few degrees from vertical to almost 90° in a few of the trees. There was no necrosis of any of the leaves or any evidence of infection by the black scorch fungus, *Endoconidiophora paradoxa* (Dade) Davidson. Some of the leaves of several trees, however, had a characteristic twist.

One of the oldest palms, with a bend in excess of 60°, was cut down and the top split to expose the bud to see whether there was any evidence of infection or tissue changes that would help explain the bending of the tops. The tissues of the bud appeared perfectly normal. The bud area itself was straight, and the bending of the top occurred above the bud.

The disorder in the Coachella Valley is believed to be different from anything reported from the Old World. It is somewhat similar to the early stages of the so-called "bending head" disease reported on several date varieties in Egypt (1) and Tunisia (2). Barhees are not grown in these areas. One of the writers (Nixon) has seen "bending head" in North Africa, where the crown of nearly all affected palms inclined more or less toward the south, but it is said of this disease that the "head first yellows, then it gradually bends until it touches the stem. Sooner or later it snaps off, leaving the long



Fig. 1. Barhee palm with bending of the top at Russel-Alexander Ranch in Coachella Valley, California. The man is standing where center leaves of the top should be. The top is bent to the south more than 30°. Photograph courtesy of W. W. Armstrong, Jr.

stems standing alone" (1). Abnormal coloring of the leaves and such pronounced bending of the crown have not been found on Barhee palms in Coachella Valley. "Bending head" in North Africa is said to be confined almost entirely to badly neglected palms. In contrast, the Barhee palms on the Russel-Alexander ranch have had continuous excellent care.

The Barhee palms on this ranch occur in two separate plantings. The older consists of 19 palms imported as offshoots from Basrah, Iraq, in 1913, and is planted in a single row along one of the ranch roads. The other is a 5-acre planting about ½ mile southwest of the older palms. A little more than half of these palms are about 30 years old, all offshoots from the 19 old palms; the rest are

somewhat younger and were offshoots taken from the older (second-generation) palms in the same block.

Since no cause of the disorder could be found, it was decided to survey the garden and record the condition of the palms from year to year. For this purpose four classes of degree of bending were established; namely, 0-5°, 5-30°, 30-60°, and 60-90°. The class 0-5° was considered as exhibiting no bending. Each tree was examined and placed in the appropriate class.

The surveys were made in October 1958 and October 1959. A summary of the observations is given in Table 1. Palms in the first fifteen rows were set out from 1929 to 1931, while those in rows 16 to 28 were set out at 3 to 4-year intervals through 1944.

¹Associate Plant Pathologist and Laboratory Technician IV, respectively, University of California Citrus Experiment Station, Riverside.

²Horticulturist, USDA Date Field Station, Indio, California.

Table 1. Degrees of bending of tops of Barhee date palms on the Russel-Alexander Ranch at Indio, California.

Location	Year	Palms Examined	Bent top classes, degrees							
			0-5			5-30		30-60		60-90
			No. of	%		No. of	%	No. of	%	No. of
			Palms			Palms		Palms		Palms
Block 1,	1958	210	108	52		89	42	13	6	0
rows 1-15	1959	210	47	23		132	63	26	12	5
Block 2,	1958	181	178	98		3	2	0	0	0
rows 16-28	1959	181	127	70		54	30	0	0	0
Block 14,	1958	19	2	10		10	53	7	37	0
single row	1959	18	0	0		11	61	5	28	2

Therefore, as a matter of convenience in presenting the data, the 5-acre planting was divided into two blocks, 1 and 2, based on the above planting dates.

In 1958 approximately 50% of the trees in block 1 were bent, mostly in the 5-30° class. By 1959, 77% of the palms in this block were bent and the severity of bending had also increased.

In block 2, only 2% of the trees exhibited any bending in 1958, while by 1959 affected palms had increased to 30%, all in the class 5-30°.

Seventeen of the 19 oldest palms were affected in 1958, whereas all 18 left after removal of one for examination in 1958 were bent in 1959, and the degree of bending had increased.

While complete fruit bunch counts were not made on either the 5-acre or single-row planting, the condition of bunches on many trees on which the bunch was still hanging or had been recently cut were observed, and all such bunches appeared to be normal. The total number of blooms and the fruit yield were available for 1958 and 1959. In the 5-acre block 812 more blooms and 18,000 more pounds of fruit were produced in 1959 than in 1958. It may be tentatively concluded that the bending of the tops of these palms has not had any deleterious effect on growth or fruit production even though the amount and severity of bending are increasing. The possibility exists, however, that the increasing number of blooms and greater yield on the unaffected younger trees coming into heavier bearing may obscure decreases

in bloom and yield on older palms whose tops are bent. In contrast, the yield from the single row of palms was less in 1959 than in 1958 partly because there was one tree less in 1959, but these palms have shown a steady decline in yield since 1956 and age may be involved.

One of the large palms in the single row was given special treatment in October 1958, wherein all of the lower leaves were cut off to leave only about twelve in the crown. At the time the palm was trimmed, the degree of bending was in class 30-60°. In 1959 the top of this tree had straightened so much that by October the tree was in the class 5-30° and appeared to be closer to 5° than 30°. The reason for straightening is not known, and on the basis of only one tree, we cannot conclude that the trimming treatment would have the same effect on other trees.

While no attempt has been made to correlate the disorder with height of palm (estimated to the bud or indicated by the heighest trunk fiber visible at the base of the youngest leaves), none of the trees less than 10 feet high were affected. On the other hand, two of the largest trees were not affected until the second year of the survey. It would thus appear that the disorder is the result of some current environmental influence on the palms, although to date no clue exists as to what this might be. All the more puzzling is the fact that in the same block with the 18 oldest palms and adjacent to them are palms of several other varieties of the same age and height, none of which show any bending. No unusual

spray or fertilizer applications have been made.

Approximately 600 Barhee palms are planted in other gardens in the Coachella Valley, and so far as is known, all of them are descendants of the 19 palms at the Russel-Alexander ranch or of a few other palms imported at the same time, in 1913. About 400 of these are less than 15 years of age and below 15 feet in height. No bending of the tops has been observed in these younger palms. The tops of several of the older and taller palms, however, were bent as much as 10-15° in a southerly direction. Two palms over 25 feet in height which have been neglected in the last few years had a pronounced bending of 45° or more. One of the writers (Nixon) also recalls that nine Barhee palms growing at the U.S. Date Field Station (removed a few years ago) were definitely bent at the top an estimated 20-30° when 18 years of age and about 20 feet in height.

From these observations, it would appear that some physiological weakness may be inherent in the Barhee variety which would explain the bending of the tops. However, V. H. W. Dowson, who spent many years as manager of a large date plantation near Basrah, Iraq, the home of the Barhee date, when recently questioned, could not recall seeing any Barhee palms affected in this manner. Furthermore, Barhee palms are characterized by heavier trunks and longer leaves with broader leaf bases than most other varieties, and one would not expect such vigorous palm characters to be associated with weakness in the bud.

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DATE CULTURE AND PROCESSING IN PAKISTAN

By Ted Carlson

Formerly with Food & Agriculture Organization of the United Nations, Pakistan

Pakistan is located on the Sub-continent of India. It is a new country, having been formed in 1948 upon the division of India into India and Pakistan. There are two parts of Pakistan, East Pakistan and West Pakistan. East Pakistan is located on the Bay of Bengal, while West Pakistan is on the Arabian Sea. Some 1,000 miles of India separate them. As East Pakistan does not grow dates, only West Pakistan will be covered in this paper.

I arrived in Karachi, West Pakistan, on 8 May 1956 to advise the Government of Pakistan on date culture, processing and marketing as an official of the Food and Agriculture Organization of the United Nations. I remained in Pakistan until January 1960. During this time I travelled extensively all through West Pakistan by air, train, bus, car and "Land Rover." I was received most hospitably in all areas.

Pakistan is the sixth largest date producing country in the world, growing some 77,000 metric tons annually from some 6,500,000 palms. All dates grown in Pakistan are of the so-called invert sugar varieties, commonly called soft dates in California. Dates are produced to some extent in all the States of West Pakistan, namely Sind, Khairpur, Punjab, North West Frontier and Makran. Production is approximately as follows:

Province or State	Number of Palms	Production in pounds
N.W.F.P.	20,000	2,033,000
Punjab	532,500	43,665,000
Sind	625,800	78,225,000
Khairpur	134,200	13,756,000
Makran	433,330	69,300,000

In checking these figures, the reader will find that there is a discrepancy. In my travels, I could get no accurate figure on either number of palms or pounds produced, so the first production figure is taken from a report by F.A.O. and the latter is taken from the Report on Marketing of Dates in Pakistan issued by the Cooperation and Marketing Department of Pakistan in 1953. I am of the opinion that both figures are on the low side. Dates are one of the most important agricultural crops of West Pakistan and in the areas grown, are an important part of the daily diet.

In general, dates are grown in a haphazard manner with little attention and care. Most of the dates are seedlings and it is quite common to see them growing in clumps with the offshoots still attached to the parent palm. Little care is given them and in many instances they are pollinated by the wind. Harvesting is usu-

ally accomplished by cutting the entire bunch when ripe and either lowering the bunch to the ground or dropping it into a basket or on to a mat. Production per palm is very low.

At the present time the Government of Pakistan is taking some interest in date culture and experimental work is going on at several Government Experimental Farms. The Agricultural College in Lyallpur is conducting experiments on varieties, pollination and processing. In addition, there are now some private plantings where dates are planted in rows with regular spacing and regular care given to them. This is especially true in Makran. In nearly all instances date palms share the land with other crops ranging from fruit trees and grapes to rice. In some districts date palms are planted on the perimeter of the plot along the irrigation canals and some other crop planted in the area between. In my opinion, this is a good practice.

The most intensive plantings of date palms are along the Indus River. History says that these palms are from the seeds of the date ration used by the soldiers of Alexander the Great when they camped along the Indus River. Date varieties are legion and any particular district can and does have a dozen or so varieties, although usually a few are outstanding. In the Punjab and Khairpur Districts it is not unusual to have rains just before the harvest season and when this happens the loss is heavy.

Processing of dates is simple, consisting of sun curing and drying on mats laid on the ground or on roof tops. Fumigation is not practiced and consequently many dates are infested. Packing is in palm leaf baskets, tins, earthenware pots, or animal skins. In some areas and with some varieties, dates are harvested just before ripening and then boiled in water and sun dried. The flavor of this type of cured date leaves much to be desired, but the method does produce a date with excellent keeping qualities. Dates are also placed in tins or earthenware pots, covered with a date syrup and sealed. The dates so packed, gradually absorb all the syrup. This pack is in much favor throughout Pakistan.

In the Makran District of West Pakistan, dates are the principal crop and are very highly regarded as a food. Here the conditions for date production are excellent, with no rains during the harvest season. Temperatures are high and humidity low. Palms are regularly planted, irrigated

and pollinated. The varieties are few and excellent. They compare favorably with any dates in the world. Holdings are relatively small, with the average grower having about 1,000 palms. Each grower takes care of his own planting and very little of the acreage is leased, as compared to the Indus River District where the holdings are large and it is customary to lease on a share basis nearly all of the date acreage. Unfortunately, as Makran is difficult to reach and not politically important, little attention is given to this District by the Government of Pakistan.

Some varieties of Iraqi dates have been imported and planted in Pakistan, namely Halawi, Khadrawi and Zahidi. These varieties have done very well and the offshoots are in strong demand.

Production of dates per palm is very low compared to California. Average production is about eighty pounds per palm. It is customary to remove nearly all the fronds from the palm as they have many uses. This severe leaf pruning is partly responsible for the low yield. Other factors are the extremely limited use of fertilizers of any kind and the overcrowding of the palms. It is a common sight to see a date palm with only four to six bunches of dates at harvest time. There are few diseases of the date palm in Pakistan. Some scale is evident and also some date mite, but neither of them is serious.

In general, conditions for date culture are excellent in West Pakistan and the tonnage produced by the present palms could be doubled or tripled by regular planting, proper care, use of fertilizers, allowing more fronds to remain on the palms, and bunch thinning. Great interest was shown by the date growers in date culture as practiced in the United States and especially in modern processing. Modern methods of processing and packing are vitally needed. At present, in spite of the large tonnage produced, West Pakistan is a date importing country, purchasing some 70,000,000 pounds of dates in 1951. This could be easily rectified with Government assistance and Pakistan could become a date exporting country.

Considering the many problems caused by its separation from India, I believe that Pakistan has accomplished a lot in the short time it has been a country. Much more will be accomplished in the future when dedicated, trained persons occupy the high places in Government.

FRUIT AND NUT CROP ESTIMATES FOR CALIFORNIA¹ AND SOME SPECIAL COMMENTS ON DATES

By Robert D. Parr²

As background information, this discussion will cover some brief comments about California's fruit and nut crop production estimates, the methods used, research being conducted toward improvements and additional supplemental data being obtained for industry use, also comments about some special work on dates during the 1959 season.

I. CALIFORNIA FRUIT AND NUT CROPS

The fruit and nut estimating work in California covers some twenty crops whose total value exceeds \$540,000,000 annually. Many of the crops are not grown in other States. Comparison to U.S. production by crops shows the fruit and nut crops in this group that represent more than 90 percent of the U.S. production are: almonds, olives, nectarines, pomegranates, figs, lemons, dried prunes, dates, persimmons, walnuts, avocados, and grapes. Plums and apricots amount to roughly 80 to 90 percent of the total. Pears and peaches fall in the 45 to 50 percent class, while crops with less than a fourth of the U.S. production are: oranges, cherries, apples, and grapefruit. A unique feature of these crops is the fact that all the crops named are ones for which very accurate figures of final production are available through various sources. A performance record of early season forecasts of such crops can be readily compiled for all to see. The brutal facts of one's forecasting abilities stand out prominently.

Users of crop forecasts can and do express in many ways an intense and ever increasing demand for accurate and timely forecasts of production.

It is easily recognized that in order to provide for orderly, efficient and equitable marketing patterns and to assist growers to obtain reasonable prices for their crops, it is imperative that accurate forecasts of production be available prior to and during any current marketing season. For those crops having alternative uses such as grapes, peaches, and pears there is an even greater need for accurate and timely estimates of total production.

In an effort to achieve best use

and value to all concerned, there are a number of industry self-help programs for some California crops administered by State and Federal Marketing Order groups. Some of the State Orders are set up to provide ways and means for industry-wide promotion of sales, the cost of which is governed by assessments collected relative to crop size. Some of the State programs and the Federal Orders provide means to adjust supplies to market demands by limiting either quantities marketed or by creation of surplus pools for other than domestic disposal so that growers, handlers, processors, and consumers benefit equally well. A direct example with which you folks are well acquainted is your presently operating Date Administrative Committee. The expressed need for accurate forecasts for these Marketing Order crops is consequently as acute as the need to establish marketing policies, especially in crop years when surpluses exist. Decisions relative to surplus controls must be made with adequate knowledge of supply and demand. Without such knowledge or with inaccurate information the wisdom of decisions or the ability of these groups and committees to regulate domestic supply with any precision is considerably weakened.

The Crop Reporting Service publishes crop forecasts each month during the growing season. These forecasts are based primarily upon growers' reports of condition of the crop in their locality as a percent of full crop. Average condition is then transformed into a forecast of production by correlating condition and tonnages for a series of years. Adjustments are applied for trends in yield and acreage changes.

Crop forecasts have, over the years, provided adequate results. In recent years, however, more precision has become necessary. Forecasts for most crops are close to actual, but in occasional years condition does not adequately reflect the true condition.

In an attempt to test some refinements to our forecasts, the collection of objective measurement data for certain crops was started in California in 1951. Assumptions made were that the factors associated with final production such as fruit count and weight of fruit are directly related to tonnages produced. Stated another way, at harvest the number of acres or trees growing a crop times the number of fruit set times weight of fruit should equal production. The determination of these factors at har-

vest is a matter of counting and measuring. By proper sampling methods, fairly accurate estimates can be obtained. Where the problem becomes particularly difficult is in shifting the time for such estimates from harvest to some date shortly after bloom. This involves forecasting growth and even the number of fruit that will remain on tree to harvest as it may be affected by weather or other factors. With this in mind, a statistically sound sampling procedure has been designed for certain crops to provide estimates of fruit counts early in the season. Size of fruit at known biological reference dates was used as an indication of final weight. Supplemental information useful to growers and handlers is the size distribution, grade and weight data made available by such sampling procedures. This data is published to a limited extent.

II. VARIOUS RESEARCH PROJECTS

The projects and their starting dates, that have been studied in detail on a full field test basis are:

1. Raisins—1949
2. Clingstone Peaches—1952
3. Bartlett Pears—1952
4. Grapes—1956
5. Lemons—1958
6. Walnuts—1958

The projects were organized primarily to study the use of objective measurement techniques for forecasting production with the exception of raisins. The raisin survey was designed to provide an early end of season estimate of total production and to study the problem of estimating grower intentions to make raisins, and within season reports of raisins laid to date. Financing of the work was carried on in a variety of ways.

Several of the projects were started as pilot studies with industry money and were later brought in as matched fund programs. In all cases the industry group participating is either a State or Federal Marketing Order Committee.

It should be mentioned, too, that the Crop Reporting Service also makes continuing acreage surveys of fruits and nuts planted by certain counties listing varieties and ages and publishes acreage estimates annually. These data are vital not only to the planning and conduct of the forecast surveys, but provide much needed information relative to fruit and nut acreage. Without these data, yield studies would be seriously hampered.

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²Agricultural Statistician, Fruit and Nut Crops, AMS, USDA, Sacramento, Calif.

III. TECHNIQUES AND METHODS FOUND TO BE MOST EFFECTIVE

Generally speaking all the forecasting projects have been conducted in much the same manner in that the various factors relating to final production were studied in detail.

The problem of maintaining the optimum sample scheme by crops is one of designing a plan that has the proper number of orchards, trees within orchard and parts of a tree that will provide unbiased estimates of set with a minimum variance for the money to be spent.

Problems were encountered in sample size needed to estimate fruit set. It was found, for instance, that there is a larger variance in counts from tree to tree between orchards than between trees within orchards. Consequently, reducing errors due to sampling could best be made by increasing the sample number of orchards. Tests are underway now to incorporate a procedure of counting fruit set along a particular path in a sample tree by selecting parts or branches proportional to their size. This, of course, reduces the number of fruit counted, but at the same time allows self-adjustment due to difference in the tree sizes. Some operational problems are encountered especially in 50 foot walnut trees and dense, bushy lemon trees. Another problem that has not been solved completely is that of the relationship of fruit sizes as of a given time to final harvest size and/or weight of fruit. In lemon production the fruiting habit of this crop is such that bloom and fruit harvest occur over a thirteen month period. The time required for a lemon fruit bud to develop to a fruit of picking size is from 6 to 8 months. Thus fruit counts as of any one time will not account for all the fruit to be harvested for a given crop year. The problem at the present time is to test a procedure for predicting lemons potentially available for picking at various dates. The harvesting practice generally is to pick lemons as of a given size rather than as to maturity. Dependent upon market demand and fruit maturity when picked, some lemons are stored up to 6 months.

It is interesting to note that there are often many useful types of supplemental information that become available from these surveys. For example, it was found in walnuts the nut shell reaches full size and hardens completely about two and a half months prior to harvest. This is useful in providing a basis for estimating size and grade composition. Such data can in certain crop years be

as important if not more so than the actual production estimate itself to those people attempting to market the crop.

IV. SOME RESULTS

The projects listed have been conducted with varying degrees of success in terms of accurate forecasts of production. The Bartlett pear program after seven years was discontinued with the 1958 season before all the problems of forecasting were solved, but some good progress has been made. Pears set per tree by areas and fruit size determination needs further study.

Important strides forward in the cling peach forecasting work have been made. Fruit set and size estimates are obtained readily; however as with pears, factors relating to sizing of fruit after reference date and disappearance of fruit set after reference date need further study.

The work on raisin grapes which is now completely industry financed is primarily concerned with estimates of total raisin production at the close of the harvest season. This estimate is used by the Federal Marketing Order Committee as the base tonnage figure for determining free, reserve and surplus tonnages and consequent restrictions on disposal. This survey has been developed to the point that adequate results are obtained by probability sampling of a known universe of raisin type grape growers. Some objective measurement data on tray counts and weights are collected to supplement growers' reports. These data provide a basis for making estimates of acreages harvested for raisins, trays laid per acre, weight per tray, and moisture content of raisins on trays with comparisons to previous years.

The grape project is still under test. We have just completed the 4th year and some of the problems that require further study are; (1) a better definition of grape bunches and accurate determination of average bunch weight; (2) bunch density; (3) drying ratio for raisins.

The second year's work on the Walnut project has been completed. An experimental forecast was considered by the Crop Reporting Board in preparing the September forecast. Supplemental information on the size and grade composition by areas and by varieties were presented to the Walnut Control Board in September. Data of this type can prove useful to the industry in developing marketing plans.

The lemon survey started last January has been designed at the present time to forecast crop tonnage potentially available for picking two, four,

six, and eight months hence. Within season sample surveys are to be made in October and February, with intermediate surveys at two-month intervals. The surveys thus far have provided indications of sizes, grade, and color or degree of maturity of lemons on tree as of particular survey dates. Projections of fruit available will be made based upon the relationship of the index of fruit count times size vs. picks to date.

Some discussions for other objective measurement projects have been held with other industry groups and some informal work is underway at the present time with the Date Industry.

While many problems exist relative to one's ability to forecast accurately agricultural production by use of objective measurement techniques, the need for such data and measures of reliability of forecast plus the supplemental information that can be obtained is of great concern to users.

DATE PRODUCTION ESTIMATES

I would now like to describe some work started on dates last July. In an effort to develop some work toward forecasting date production, the Date Administrative Committee last spring authorized sufficient funds to carry out some preliminary field tests with an informal arrangement with our office on survey design and analysis. The use of objective measurement techniques was decided upon as a starting base. A sample of ten gardens was selected from our records. These gardens were mapped and random palm locations drawn. Bunch counts were made on four palms, and from one random palm and bunch an inspection at close hand was made to count the number of strands. One to three strands, depending on size of bunch, were cut off and bagged. Later in the lab fruit buds, both pollinated and unpollinated were counted, fruit was sized and weighed. Survey dates were July 18, August 22, and September 12. At harvest time a probability sample of dates inspected were graded, sized and weighed. Data from this sample have not been analyzed as yet.

The following tables summarize the data collected. Further analysis and recommendations as to sample size needed to estimate bunch, strands and fruit per strand will be presented to the Date Administrative Committee at a later date.

Objective Measurement Data for 1959 Crop by Surveys

Measure	Unit	July 18 Survey			August 22 Survey			September 12 Survey		
		Number Measured	Average	Relative Standard Error as % of Average	Number Measured	Average	Relative Standard Error as % of Average	Number Measured	Average	Relative Standard Error as % of Average
Bunches per Palm	Each	80	14.388	2.3	72	14.194	2.5	80	14.400	2.3
Strands per Bunch	Each	40	37.850	3.9	54	38.481	2.8	60	37.633	2.6
Fruit per Strand	Each	57	32.561	4.4	52	36.577	3.8	60	34.950	4.5
Strand Weight	Grams	55	332.8	4.4	57	464.2	4.8	60	401.1	4.5
Strand Length ¹	Inches	53	15.5	3.3	60	15.6	2.5	60	15.4	2.8
Fruit Length	CM	1,852	4.005	....	675	4.316	....	592	4.134	....
Fruit Width	CM	1,852	2.079	....	675	2.090	....	592	2.032	....
Fruit Weight	Grams	1,852	10.094	....	675	11.929	....	592	11.462	....
Pit Weight	Grams	1,843	1.146	....	675	1.219	....	591	1.070	....

¹Length measured at fruiting portions of strand only.

Robert D. Parr
California Crop and Livestock Reporting Service
P. O. Box 1258, Sacramento 6, California

EFFECTS OF SOURCE OF NITROGEN AND RATE OF APPLICATION ON YOUNG NON-BEARING MEDJOOL DATE PALMS

By J. R. Furr and W. W. Armstrong, Jr.

Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture
U. S. Date Field Station, Indio, California

Little experimental fertilization of young date palms from planting time until they attain bearing age has been reported. Growers appear to have little doubt that date palms planted on soils of low fertility such as many of the virgin soils of the Coachella and Superstition series need to be fertilized during the non-bearing period as well as after they are in full bearing, but, so far as the writers are aware, experimental evidence that newly planted offshoots or young non-bearing palms will respond to nitrogen fertilization is lacking, even though most Coachella Valley soils planted to dates are deficient in nitrogen.

In a 5-year fertilizer test conducted in the nursery row and later in the field, liberal applications of nitrogen did not improve growth, inflorescence production or yield of Deglet Noor palms growing on Indio loam, though a small but significant increase in the nitrogen content of the leaves of the fertilized offshoots was obtained (2). The soil on which the test with Deglet Noor offshoots was conducted, though not regarded as a high-nitrogen soil, evidently provided the young palms with ample nitrogen during the test.

Though, according to Popenoe (5), the Arabs never use manure or other fertilizer in planting offshoots, application of manure, well-mixed with the soil or buried below the planting hole, has long been a recommended practice in this country (1, 4). For 5 or 6 years from planting to bearing age of the palm, however, there is a dearth of information and specific recommendations on fertilization.

To obtain information regarding

the influence of source of nitrogen and rate of its application on young non-bearing date palms a test using Medjool palms growing on Coachella fine sand was conducted from the Spring of 1956, a year after planting, to the spring of 1960, the first year of fruiting.

DESCRIPTION OF EXPERIMENT

Well-rooted offshoots, selected for uniformity in size, were grown in nursery for 2 years. The nursery was on Coachella find sand on which dates had been grown previously. In spite of good care the offshoots did not grow vigorously in the nursery and when removed for planting in the experimental field were found to be heavily infested by a nematode that had caused the production of knotty and distorted roots.

The offshoots, which were fairly uniform, were planted in spite of the nematode injury, since silty layers occur near the soil surface of the experimental field and it was assumed that the offshoots would soon recover from the nematode damage when planted on a soil of considerably higher silt and clay content than that of the nursery. Seven offshoots were planted 27 feet apart in each of 7 rows 30 feet apart.

Fertilizer was applied each year to single tree plots in a 7 x 7 Latin square design. The treatments were as follows:

- Control, no nitrogen (No),
- 2 pounds of nitrogen from ammonium nitrate (N2),
- 4 pounds of nitrogen from ammonium nitrate (N4),

D. 6 pounds of nitrogen from ammonium nitrate (N6),

E. 4 pounds of nitrogen from manure (Nm4),

F. 6 pounds of nitrogen from manure (Nm6),

G. 4 pounds of nitrogen from manure and and 4 pounds of nitrogen from ammonium nitrate (Nm4+N4).

The ammonium nitrate was put on in two equal applications: one in April, the other in August. Steer manure containing about 2 percent nitrogen was applied in April of each year and disked into the soil. The fertilizers were spread over the entire area assigned to a tree (30 x 27 feet) regardless of the tree's size.

Deglet Noor palms had been grown from 1941 to 1954 on the area in which the Medjool offshoots were planted, and the soil had become infested by nut grass (*Cyperus rotundus* L.). Infrequent shallow cultivation and frequent spraying with weed oil in the growing season adequately controlled the nut grass on all plots except those on which manure was applied.

Leaf growth of the young palms during the first growing season of the test (1956) was determined by measuring the new growth above the cut-off midribs of the offshoot after fertilizers were applied in early April. In the growing season of 1959 tapes were attached to young leaves on each palm and growth rates were determined by measuring the amount of leaf elongation at intervals of several weeks. The height of each tree from ground surface to fiber line was measured in February 1959 and again in April 1960.



Figure 1. The range in size of Medjool date trees under treatment C. Upper, the smallest tree and lower, the largest tree. Photographed April 24, 1960.

In April 1960 the inflorescences (bunches) that had emerged from each tree were counted. The various measurements indicated differences in growth, size or potential fruit production of the different palms.

RESULTS

The variations in average growth of young elongating leaves on the trees under the different fertilizer treatments during the first growing season (1956) and the last growing season before the termination of the experiment (1959) apparently were

unrelated to the treatments (Table 1). In the growing season of 1956 the greatest average growth was made by trees that received only 2 pounds of nitrogen per year and in the growing season of 1959 under only one treatment (E) was the growth rate of leaves higher than that of trees in the control plots.

The average height of the trees under the different treatments as shown by measurements made in February 1959 and April 1960 suggests a possible relation between tree height and amount of nitrogen ap-

plied; that is, the average tree height increases in the same order as the amounts of nitrogen applied under treatments A, B, C, D that received nitrogen from ammonium nitrate; but under treatments E, F, and G that received nitrogen from manure or from manure and ammonium nitrate the relationship does not hold (Table 2). In general, tree height of the tallest tree under each treatment (except those under which manure was supplied) increased progressively with increasing amounts of nitrogen applied. An examination of the range in height of trees under each treatment (Table 2) shows that the trees were highly variable. The wide range of tree size under some treatments is illustrated by photographs taken in April, 1960 of the smallest and the largest tree under treatment C (Fig. 1). Analysis of the data related to tree height shows that none of the differences are statistically significant.

Table 1. The average leaf elongation per tree of Medjool dates under different nitrogen fertilization treatments, 1956 and 1959.

Treatment	Apr. 5, '56 to Jul. 20, '59 to	
	Jan. 2, '57	Nov. 4, '59
	(cm.)	(cm.)
A (No)	64	306
B (N ₂)	140	279
C (N ₄)	52	241
D (N ₆)	64	273
E (Nm ₄)	27	310
F (Nm ₆)	46	254
G (Nm ₄ +N ₄)	82	272

Table 2. The average tree height and the range in height of Medjool date trees under different nitrogen fertilization treatments.

Treatment	Feb., '59		April, '60	
	Av. Ft.	Range Ft.	Av. Ft.	Range Ft.
A (No)	2.1	1.3-3.0	4.3	3.1-5.6
B (N ₂)	2.4	1.3-3.1	4.4	1.8-5.6
C (N ₄)	2.5	0.4-3.8	4.5	1.2-6.3
D (N ₆)	2.9	0.8-5.1	5.0	1.7-7.3
E (Nm ₄)	2.4	1.5-3.7	4.5	3.0-6.2
F (Nm ₆)	2.6	2.0-3.3	5.0	4.2-6.0
G (Nm ₄ +N ₄)	2.3	1.8-2.5	4.6	3.3-5.9

The average number of bunches produced per tree and the range in number per tree under the different treatments were determined from counts made in the spring of 1960. These data (Table 3) show no obvious relation between the number of bunches produced and the fertilizer treatments. It is suggestive, however, that under treatments A, B, C, D (those under which no manure was applied) the top of the range in number of bunches produced per tree is in the same order as the amounts of nitrogen applied per tree.

In contrast to the uncertain response of the palms to the fertilizer, that of the nut grass was obvious by inspection. The ammonium nitrate improved growth of the nut grass only slightly, but the manure stimulated it into extremely vigorous and luxuriant growth. In fact, growth of

the nut grass on the manure plots was so vigorous that control was difficult and least effective on these plots. Soon after the field was cultivated or sprayed with weed oil the nut grass on the manure plots formed a dense, dark-green sod, which must have offered considerable competition to the dates.

Table 3. The average number of bunches per tree and the range under different nitrogen fertilization treatments of Medjool dates in 1960.

Treatment	Av.	Range
A (No)	4.6	1-8
B (N ₂)	4.4	0-10
C (N ₄)	5.1	0-12
D (N ₆)	5.3	1-15
E (Nm ₄)	6.0	0-13
F (Nm ₆)	6.1	0-10
G (Nm ₄ + N ₄)	4.1	0-10

DISCUSSION AND CONCLUSIONS

The soil on which the young palms in this test were grown was almost certainly not high in total nitrogen (3), but dates apparently do not have a high nitrogen requirement and are vigorous foragers (2). The color of the leaves of trees on non-fertilized control plots did not show evidence of nitrogen shortage, so that if the unfertilized trees suffered nitrogen deficiency it was probably not acute.

The nitrogen supplied by the unfertilized soil was, however, probably not adequate for maximum growth of the palms. Citrus trees on adjoining plots responded vigorously to nitrogen fertilization and so did the nut grass growing around the palms. The nitrogen applications probably had some influence on the growth of the young palms, but very large differences between treatments would have been required to mask the effects of the great variability in growth of palms under the same treatment and to produce significant differences between treatments. Apparently much of the variability in growth within treatments resulted from unsuspected variability in the offshoots when they

were transferred from nursery to fertilizer plots. At the time of cutting, the offshoots had been carefully selected for uniformity so that it seems possible that nematode damage in the nursery caused their extreme variability in the field. After they were planted in the experimental plots, all the trees lived and some under each treatment grew vigorously, while others seemed to be stunted and grew slowly regardless of treatment. It was not feasible to maintain satisfactory control of the nut grass at all times and consequently trees on the manure plots probably were more seriously affected by competition from the nut grass than trees on other plots.

In addition to the ill effects of nematodes and nut grass, the trees may have been influenced by residues from the Deglet Noor palms that were removed from the field 2 years before the young Medjool trees were planted. If so, the influence of the palm residues may have varied because the relative positions of the old and young palms varied as a result of a change in planting distance.

Though the different fertilizer treatments did not effect significant differences in growth or in number of bunches produced by the young palms, the results are, nevertheless, of value. Such factors as nematode infestation of offshoot roots in light sands during the first 2 years of growth may damage the roots and possibly cause stunting from which the young trees will not recover readily even on good soil. Heavy applications of manure to young non-bearing palms that do not shade the ground enough to depress growth of the nut grass may actually do more harm than good unless highly effective measures are taken to control the nut grass. It is clear from this experiment that even better than average cultural care (watering, fertilization, weed control, etc.) may not quickly induce vigorous growth in stunted offshoots so that differences which existed at planting

become relatively less as the trees grow older. In this planting, on the contrary, the differences between the vigorous palms and the stunted ones became greater with time after planting.

SUMMARY

Young non-bearing Medjool date palms planted in a 7x7 Latin square design on Coachella fine sand were supplied nitrogen from ammonium nitrate, manure, or a combination of the two at annual rates of 0, 2, 4, 6, or 8 pounds per tree for 4 years just prior to bearing the first crop. Significant differences between treatments in growth of trees or in bunch production near the end of the test were not obtained. Fertilization may have influenced growth, but possibly because of extreme variability of palms within treatments significant differences between treatments were not obtained. Nematode infestation of the roots during 2 years when the offshoots were grown in a nursery on light sand may have caused the great variability in growth of the young palms under the different fertilizer treatments.

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CONDITIONS AFFECTING SALT ACCUMULATION IN COACHELLA VALLEY DATE GARDENS

By W. W. Armstrong, Jr.¹

Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture
U. S. Date Field Station, Indio, California

Since Colorado River water was made available to farmers in the Coachella Valley, the per-acre-use of water has increased, vast areas of new land have been brought under irrigation, and the underground water-table has risen to levels of 10 feet or less beneath thousands of acres. Colorado River water contains about 750 parts per million of total dissolved solids. If 10 acre-feet per acre per year are applied, each 4 acres will receive the equivalent of one 40-ton freight car of salt. Unless this salt is removed from the soil by careful application of sound irrigation practices, it can accumulate to disastrous levels.

The U. S. Salinity Laboratory (8) has compared the responses of plants grown in saline and non-saline soils and has established salinity levels at which yields of plants grown in saline soil are reduced to 50% of the yields of plants growing under non-saline, but otherwise identical, conditions. Using the electrical conductivity of the saturation extract (ECe)² as a measure of salinity in the soil, the Salinity Laboratory grouped plants into low, medium, and high salt-tolerance classifications. While levels have not been firmly established for many fruit crops, work with vegetable, field, and forage crops has indicated that such plants as barley, asparagus, beets, and cotton have high salt tolerance and exhibit a 50% decrease in yield when grown in soils having ECe values in the range of 10 to 18 mmhos/cm. The date palm is the only fruit crop included in the high-salt-tolerance classification. Some field crops exhibit intervarietal differ-

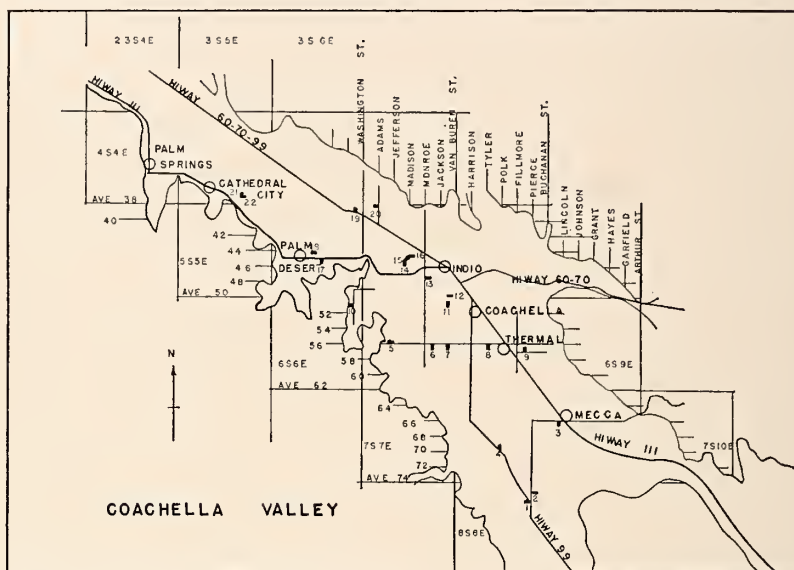


Figure 1. The geographic location of the date gardens sampled in the Coachella Valley to determine salt accumulation.

ences in salt tolerance (5), and the experience of date growers shows that date varieties also differ in salt tolerance. The broad range of conductivity from about 10 mmhos/cm to about 18 mmhos/cm probably includes the level associated with a decrease in yield of 50% for the common varieties of dates.

The salinity levels associated with 50% decrease in yield of field, vegetable, and forage crops reported by the U. S. Salinity Laboratory were obtained by confining the entire root system of the plant in the saline environment. The soils of Coachella Valley are recent, alluvial, and irregularly stratified. Strata of low permeability are generally more saline than strata of high permeability so that the root system of trees in the Coachella Valley is often distributed among zones of low, medium, and high salinity. Observations on citrus show that where even a moderate portion of the root system is in soil of salinity much higher than the critical level, a response is obtained.

There is no level at which sudden and clear-cut response to salinity is obtained. Several workers found that growth of many plants decreased uniformly as salinity increased (1, 4, 7, 9). Growth and yield of the date palm are probably adversely affected by levels of salinity much below that associated with a 50% reduction of yield.

Twenty-two date gardens in the Coachella Valley and one garden in the Chuckawalla basin were surveyed during the past year in an effort to determine what effect such factors as soil type, salinity status prior to cultivation, depth of water table, and irrigation management have had on salt accumulation. This paper reports the results of that survey.

METHODS

Figure 1 indicates the geographical location of each of the 22 gardens sampled in the Coachella Valley. The survey was conducted primarily in gardens of the Deglet Noor variety, but gardens 3, 8, and 22 were all or partly other varieties.

A wide variety of soil types, ranging from heavy, sticky Indio clay to coarse, permeable Superstition sand, were included in the survey (Table 1). Most of the gardens were on soils of medium-light texture, Indio very fine sandy loam, Coachella very fine sand, and Coachella fine sand.

Composite samples were taken in each block of dates included in the survey in two locations about 45 feet downhill from the upper end of the run and in two locations 45 feet uphill from the lower end of the run. At each location, samples were taken in one foot increments to a depth of 2 feet and in 2 foot increments from 2 to 6 feet. In some gardens where permanent - border - irrigation systems

¹The author is indebted to the cooperating growers and to the personnel of the C. V. County Water District, especially to Lowell Weeks and J. R. Spencer, for information and assistance pertaining to the water table, and to L. V. Wilcox, U. S. Salinity Laboratory.

²Electrical conductance is expressed in reciprocal ohms (mhos) and electrical conductivity is expressed in mhos per centimeter. The mho/cm is a large unit and most saturation extracts have conductivities more conveniently expressed as thousandths of mhos: millimhos/cm, or mmhos/cm. The term ECe is used in this paper as an abbreviation of the phrase: electrical conductivity of the saturation extract of the soil or of soil samples.

were used an additional set of samples was taken through the crown of the border. In other gardens samples were taken to greater depths in order to determine the level of the water table. The soil was considered to be within the water table when it was saturated at the time of sampling. The soil samples were wet to saturation, the saturation extract removed by suction and the electrical conductivity of the extracts determined as described in the U. S. Salinity Laboratory Handbook (8).

RESULTS AND DISCUSSION

Inter-relation of salinity, soil type, water table, and stratification

The contribution to salinity of such factors as soil type, water table, and restrictive layers was difficult to identify because the area of high water table (figure 2) coincided with the area of heavy, stratified soils that most commonly had restrictive layers. These soils were described by Kocher and Harper (6) in the 1923 Coachella Valley Soil Survey. The effects of the three factors were additive so that when all were present salinity was high. The combination of factors was exhibited by gardens 2, 3, and 8. Garden 8 was the most saline of all surveyed in the Coachella Valley, with more than half of the ECe values above 15 in the upper 8 feet and less than one-third with ECe values of less than the critical level, 10 mmhos/cm. This garden was not irrigated; the water used by the palms came from the underground water table. Very small crops of cull fruit were produced and the trees had only a few, small, yellow leaves. Garden 3 also had not been irrigated in many months, but it was somewhat less saline. Garden 2, located in a heavily tiled area and on a somewhat less impervious soil than gardens 3 and 8, had been irrigated regularly, and in the wetted area had ECe values generally less than 5. Garden 5 illustrated the effect of water table. The soil in garden 5 was at least as heavy as the soil in garden 2, and the restrictive layers were as dense. Gardens 5 and 2 received comparable amounts of water, but garden 5 lay well outside of the 10-foot water table contour and ECe values in garden 5 were all less than 3 mmhos/cm. The palms in gardens 2, 3, and 8 appeared to be weak, had many yellowed pinnae, and had consistently produced relatively poor fruit.

Gardens situated on Indio very fine sandy loam were generally less saline than those on the heavier Indio clay, clay loam, loam, and Woodrow loam, but the presence of silt or clay layers thick enough to restrict downward water movement and of a high water table allowed salt accumulation

Table 1. Relation of ECe to soil type, soil stratification, water table and water use in 22 Coachella Valley date gardens.

Garden No.	Irrigation water Source	Ac. ft./ ac./year	Water table ft. ¹	Soil type ²	Layers of low perm. top 6 ft.	Yield	Maximum ECe mmhos/cm.
3	....	0	<10	Indio c.	Yes	Poor	>10
8	....	0	<10	Indio c. l., sl.	Yes	Nil	10-15
2	Canal		<10	Woodrow l.	Yes	Poor	<5
5	Canal		>10	Indio l.	Yes		<3
1	Canal	>10	5.5	Indio v. f. s. l.	Usually	Good	6-8 (9-12)
9	Canal & well		7	Indio v. f. s. l.	Usually	Good	2-6
11	Canal			Indio v. f. s. l.	Usually	Good	2-3
14	Canal			Indio v. f. s. l.	Usually	Good	2-3
15	Canal			Indio v. f. s. l.	Usually	Good	2-3
16	Canal	6		Indio v. f. s. l.	Usually	Good	5
4	Canal	>10	>10	Coachella v. f. s.	No	Good	Nonsaline
6	Canal	12-15	<10	Coachella v. f. s.	No	Good	<2
7	Canal	<10	7-8	Coachella v. f. s.	Yes	Good	4-11
10	Well	>10	>10	Coachella v. f. s.	No	Good	Nonsaline
12	Canal	>10	>10	Coachella v. f. s.	No	Good	Nonsaline
18	Well	>10	>10	Coachella v. f. s.	No	Good	Nonsaline
13	Well & canal	6	>10	Coachella f. s.	No	Small poor	<4
19	Well	Large amount	>10	Coachella f. s.	No	Good	<4
20	Well	Large amount	>10	Coachella f. s.	No	Good	<4
21	Well	<10	>10	Coachella f. s.	No	Avg.	<4
22	Well		>10	Coachella f. s.	No	Good	<4
17	Well	12	>10	Superstition s.	No	Good	<1.5

¹<=less than; >=greater than.

²Abbreviations: c, clay; c. l., sl, clay loam, silty phase; l, loam; v. f. s. l., very fine sandy loam; v. f. s., very fine sand; f. s., fine sand; s., sand.

to reach damaging levels in some gardens.

Garden 1 was included within the 10-foot water table contour several years before the survey and part of the area sampled was tiled in 1955. Clay and silt strata of variable thickness and depth below the soil surface characterize the profile in this garden. In the tiled area, the water table was at 5½ feet and even though the owner habitually used large quantities of water in an irrigation system well

designed to limit salt accumulation, ECe values of 6 to 8 mmhos/cm were common in and adjacent to the clay layers and just above the water table. In one spot the palms appeared weak, had fewer leaves and bunches than in the rest of the garden and produced small crops of fruit of marginal quality. In this area the restrictive layers were especially thick and dense and ECe ranged from 9 to 12 mmhos/cm in the lower 4 feet of the 6-foot profile. The trees in this area

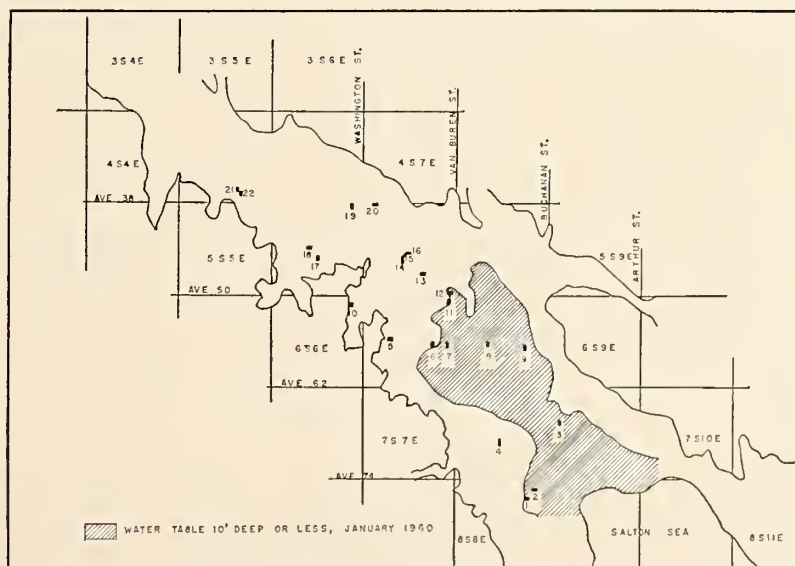


Figure 2. Location of the sampled date gardens in relation to high water table.

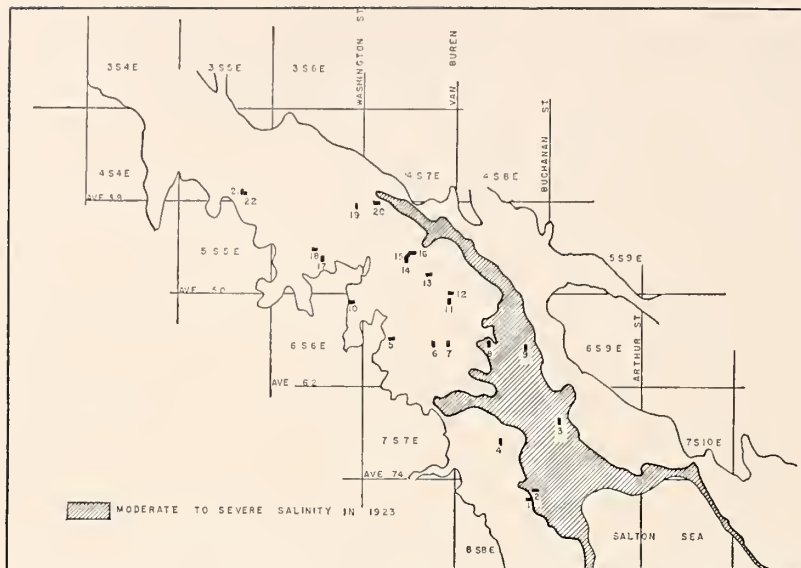


Figure 3. Location of surveyed date gardens in Coachella Valley in relation to the area where native soil salinity was high, greater than 0.6 percent total salts in the soil.

exhibited a large response to high salinity while the palms in the rest of the garden did not.

In the same garden, where tile had not been installed and less water had been applied. ECe values were above 6 mmhos/cm throughout the profile except in the top foot, with maximum salt accumulation (ECe of 13 mmhos/cm) at 3 to 6 feet. The less saline portions of this garden had consistently produced large crops of good-quality fruit.

The water table beneath garden 9 was stabilized at about 7 feet during the 2 years before the survey by tile; so less salt accumulation was found than in garden 1. ECe values of less than 2 mmhos/cm occurred in the top 2 feet, but at 5 and 6 feet, just above the water table, ECe values were 6 mmhos/cm.

Garden 11 was included within the ten foot water table contour for the first time in 1959. While this garden has underlying restrictive layers of variable thickness and depth similar to those found in gardens 1 and 9, very much less salt accumulation had occurred. The maximum values, ECe of 3.2 mmhos/cm, were in the 5- and 6-foot samples. Values less than 2 mmhos/cm were common in the rest of the profile.

Gardens 14, 15, and 16 are in the area of low water table, and while the soil contained silt and clay strata, restrictive layers as heavy as those found in gardens 1, 9, 11, and 12 were occasionally found. ECe values were generally less than 2 or 3 mmhos/cm in these gardens at all depths. Garden 16, on the U.S. Date Field Station, is in an area in which an irrigation experiment had limited

water application to 6 acre-feet per acre per year (3). ECe values of about 5 mmhos/cm were found throughout the profile except in the top foot.

Coachella very fine sand is less stratified and more permeable than any of the soil types so far considered. Restrictive layers dense enough to retard drainage appreciably were found only in garden 7. The water table had slowly risen and was at about 7 to 8 feet through the year prior to sampling, but no tile had been installed in this garden at the time of sampling. ECe values of 7 to 11 mmhos/cm were usual at depths greater than 5 feet, 4 to 7 mmhos/cm were common at 2 to 5 feet of depth, and ECe values of 1 to 4 mmhos/cm were obtained at less than 2 feet of depth. Water use in this garden was relatively low, less than 10 acre-feet per acre per year. This garden had consistently produced large crops of high-quality fruit. The soil of garden 6, half a mile west of garden 7, was similar except that no restrictive layer was present in the profile sampled. The water table was several feet lower than in garden 7, and the owner applied 12 to 15 acre-feet of water per acre per year. In garden 6 the ECe values obtained were generally less than 2 mmhos/cm.

The soil in gardens 4, 10, 12 and 18 contained no restrictive layers. The water table was below 10 feet in all, but in garden 12 it was slowly rising. All these gardens used 10 acre-feet of water per acre per year or more, all were non-saline and all produced good crops of above-average fruit.

Coachella fine sand was one of the

least saline soils surveyed. While this soil was strikingly stratified in all the gardens sampled, in no case were restrictive layers encountered. The water table was below 10 feet in all gardens on this soil. Gardens 19, 20, 21, and 22 had never used Colorado River water, all but 22 used large amounts of high-quality well water, and all were non-saline. ECe values were not above 4 mmhos/cm at any level.

A cooperative irrigation trial was begun in 1955 in garden 13. The dry plots in this garden received 6 feet of canal and well water in about equal proportions. These plots were sampled to a depth of 16 feet. In general the 16-foot profile consisted of about 2 feet of sandy loam topsoil and of 2 to 6 feet of silty material, underlain by fine to coarse sand to 16 feet. In the silty layers ECe values of 4 mmhos/cm were obtained, but in the sandy loam above and in the sand below the silt ECe values ranged from 0.4 to 1.5 mmhos/cm. The moisture content of the samples indicated that irrigation water was not penetrating below 6 feet in this soil; so very little leaching had been accomplished. These dry plots produced limited crops of poor-quality fruit, but the reduction of yield and quality was probably due to very limited water supply rather than to high salinity.

Soils of the Superstition series are characterized in part by very high permeability, low water-holding capacity, and stratification with coarse materials (6). The sandy loam topsoil in garden 17 was underlain at a depth of less than 2 feet by sand which gradually became coarser so that at 6 feet gravel up to an inch in diameter occurred. This garden was irrigated with about 12 acre-feet of well water per acre per year and had produced large crops of high-quality fruit. Only one ECe value exceeded 1.5 mmhos/cm.

Relation of recent salt accumulation to native salinity

The hatched portion of Figure 3 delineates that area of Coachella Valley designated by Kocher and Harper (6) in 1923 as including primarily "alkali" soils of moderate to severe salinity. Soils of moderate to severe salinity contained more than 0.6 percent of total salts. ECe values of non-organic soils containing 0.6 percent or more total salts generally exceed 14 mmhos/cm. The soil of gardens 2, 3 and 8 was severely saline in 1923, and while less saline than in 1923, was still very saline in 1959. Garden 9 lies in a small area of soil much less saline than surrounding areas, but the scale of the map is such that this small area of only slightly saline soil could not be shown. In general, however, the areas that were

severely saline in 1923, as indicated by Kocher and Harper (6) are still among the most saline in the Coachella Valley.

Relation of irrigation practice to salinity

Water was applied to the soil in a variety of systems in the 23 gardens, ranging from small V furrows to bordered basins of nearly an acre in area, but by far the most common was the use of permanent borders in the tree row. In general, where more than 10 acre-feet of water per acre per year were applied using permanent borders little or no salinity was found in the upper feet of the profile. Where restrictive layers occurred within the sampled profile or where the water table was at less than 10 feet of depth, ECe values of 9 or 10 mmhos/cm were common in the restrictive layers or just above the water table. When samples were taken through the crown of the permanent borders, extreme salt accumulation had occurred in the borders. The greatest border effect occurred in garden 1. The ECe ranged from 1.1 mmhos/cm to about 3 mmhos/cm in the top 4 feet beneath the irrigated area, but beneath the dry borders the soil had a maximum ECe of 8 mmhos/cm at 2 feet and 4.5 mmhos/cm at 4 feet. At depths below 4 feet ECe increased beneath both the border and wetted area to about 10 mmhos/cm because of the influence of the water table at 5½ feet. About 0.75 percent of the soil in the top 5 feet in this highly saline area had been raised to an ECe of 8 mmhos/cm or more and about 4 percent to 4 mmhos/cm by the border effect. While heavy rooting was evident in the dry border, salt accumulation in and beneath permanent borders was not sufficient to injure the palms materially. In gardens 7, 14, 15, and 17, all less saline than garden 1, high salinity was usually found in the top foot of the dry border, but at lower depths only occasional ECe values were greater than 4 mmhos/cm.

Garden 13 received barely enough water, 6 acre-feet per acre per year, to supply the water requirement of the trees (2) but not enough to remove salts. ECe values ranged up to 4.6 mmhos/cm. In garden 6 in a soil similar to that of garden 13, from 12 to 15 acre-feet per acre per year were supplied and the maximum ECe obtained was 2.0 mmhos/cm. Neither garden was affected by high water table or restricted drainage.

Garden 1, where a very restrictive layer and a high water table occurred, was originally sampled in August 1959. About 5 acre feet of water were applied per acre during the winter in an effort to leach out the salts, and the garden was again sampled in March 1960. The most saline area

sampled in August in this block had ECe values ranging from 3.6 mmhos/cm in the top foot, 6.0 in the second to 9.0 in the 5th and 6th. Leaching reduced ECe to 2.6 mmhos/cm in the top foot, 5.0 in the second, and 7.5 in the 5th and 6th. This result was encouraging in view of the difficult management problem.

Gardens 21 and 22 are adjacent and water is obtained from a common well. In garden 21 water was applied to the trees in a ditch about 8 to 10 feet wide down the tree row, leaving a dry area about 20 feet wide between the rows. The leaves were yellow, and while figures for water use in this garden were not available, probably no more than 5 or 6 acre-feet per acre per year were used. In garden 21 ECe values ranged up to 3.4 mmhos/cm. Garden 22 was irrigated between temporary borders, the entire soil surface was wet and about 11 acre-feet per acre per year were applied. The highest ECe obtained was 0.5 mmhos/cm. Garden 22 is noted for high quality fruit.

Irrigation water in the Coachella Valley varies from well water containing much less than 100 p.p.m. total dissolved solids to Colorado River water containing more than 700 p.p.m. Garden 23 in the Chuckawalla Basin was the most saline surveyed and illustrated salt accumulation when extremely saline water was used. Most of the palms were transplanted into the garden as mature trees in 1955-56 and water was applied by flooding between temporary borders. The well water varied in salinity with the season, but contained in the range of 4,000 to 6,000 p.p.m. total dissolved solids, and between 15 and 20 acre-feet per acre per year were applied. About one-third of the samples had ECe values greater than 10 mmhos/cm, several ECe values were greater than 20 mmhos/cm, and one sample had an ECe of 45 mmhos/cm. No sample, even from the top foot, had an ECe of less than 4 mmhos/cm.

Effect of salinity on growth

The palms growing in the highly saline spot in garden 2, all of the palms in garden 8, and the palms transplanted into garden 23 in 1955-56 had fewer leaves and, except in garden 23, had fewer bunches than normal palms, the leaves were smaller and more yellow and, except in garden 23, the crop smaller and of lower quality than in less saline gardens. Garden 23 had produced no fruit since transplanting. The highly saline spot in garden 2 had ECe values that ranged from 9 to 12 mmhos/cm in the lower 4 feet of the 6-foot profile, garden 8 had more than half of the ECe values above 15 mmhos/cm in the top 8 feet and

garden 23 had ECe values that ranged up to 45 mmhos/cm.

While the reduction in yield and growth in the highly saline spot in garden 2 was probably not as great as 50%, certainly in garden 8 the salinity level associated with a decrease of 50% in yield and growth was surpassed. The appearance of the trees in garden 23 indicated that salinity was high enough to very severely depress growth.

CONCLUSIONS AND SUMMARY

A survey was conducted to determine the salinity status of some representative date gardens in the Coachella Valley. Where the soil was of fine texture, where layers of clay or silt effectively limited drainage, where the water table was high, or where combinations of these conditions occurred salinity was higher than where these conditions or combinations of conditions did not occur. Improvement of these saline situations may be possible under ordinary circumstances since, in one moderately saline garden in which there were restrictive layers and high water table, salts were reduced by exceptionally heavy water applications.

While the method of irrigation was not of great importance, less salt accumulation occurred in the upper 4 feet of soil in gardens where practically all the soil was wetted than in gardens where most of the soil surface was dry.

Gardens that used 10 acre-feet of water per acre per year in areas where native salinity was low remained non-saline, but where as little as 6 acre-feet per acre per year were used salt accumulated even when the water applied was very low in total salts. In gardens where water penetration and drainage were slow or in gardens where clay lenses seriously reduced permeability even 10 acre-feet per acre per year were not sufficient to prevent salt accumulation in and near the restrictive layers.

Where highly saline water, containing up to 6,000 p.p.m. total dissolved solids, was used, even applications of more than 15 acre-feet per acre per year were not successful in reducing salt accumulation to acceptable levels.

Where ECe values exceeded 10 mmhos/cm in strata that occupied more than a moderately small portion of the root system severe symptoms of excess salinity appeared in the palms. Observation indicated that the salinity level associated with 50% decrease in yield and growth is in the range of from 10 to 20 mmhos/cm.

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OBSERVATIONS ON DATE CULTURE IN LIBYA AND TUNISIA

By Roy W. Nixon

Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture
U. S. Date Field Station, Indio, California

When I was sent to Libya as a delegate to the First International Technical Meeting on Date Production and Processing, sponsored by the Food and Agriculture Organization of the United Nations and held at Tripoli December 5 to 11, 1959, I received invitations from the governments of Libya and Tunisia to visit date areas in those countries. I arrived in Tripoli November 16, made the Tunisian trip November 22 to December 4, and visited the most important places where dates are grown in Libya between the date meeting and my departure on January 15.

A lot of territory was covered in a short period of time, thanks to USOM (United States Operations Mission—"Point 4"), which is well organized in both Libya and Tunisia and made all arrangements for travel. Transportation was provided by car except for a visit to the Fezzan, the southern province of Libya, by plane, which made it possible to cover in 6 days distances that otherwise would have taken about 3 weeks. In Libya I was accompanied by F.A.O.'s date expert, V. H. W. Dowson, whose knowledge of the country and language was invaluable. In all places visited the government officials were most friendly and cooperative.

As date culture in both Libya and Tunisia has been described in some detail in earlier Reports of the Date Growers' Institute (1, 3, 4, 5) I shall try to confine my remarks to observations not covered by others except for a brief review of the geography and climate.

GEOGRAPHY AND CLIMATE

Libya is about one-fourth the size of the United States. It is located on the southern coast of the Mediterranean and is bounded on the east by Egypt and Sudan, on the west by

Tunisia and Sahara (formerly southern Algeria) and on the south by French West Africa and French Equatorial Africa. Tunisia is a much smaller country, only a little larger than southern California below the Tehachapi Mountains. It occupies the northeastern corner of the "bulge" of north Africa with the Mediterranean on the north and east, Libya on the lower east boundary, and Algeria and Sahara on the west and south.

The climate along the coast of both countries is somewhat like that of the coast of southern California, except that along the Mediterranean, summer temperatures are higher and there is less fog. Winter rains and dry summers are characteristic. The climate of the interior desert portions of both Libya and Tunisia is not unlike that of Coachella Valley, but, according to available records, slightly hotter and drier in some parts of southern Libya.

CONTRASTS IN DATE CULTURE

There are striking contrasts in date culture between Tunisia and Libya. Most of the Tunisia's 2.7 million date palms are in an interior desert basin relatively small as compared with the vast desert spaces of Libya. Most of these palms are given good care with cultivation and irrigation usually primarily for the dates. There is a well-established export trade of one variety, the Deglet Noor, the high quality of which is generally recognized. Libya, according to recent estimates (2), has about 5 million palms, which are very widely scattered. Two million of them are along the coast of Tripolitania, the northwestern province, in a narrow strip 10 miles wide and 250 miles long, and the others are in various oases separated in some instances by as much as 500 or 600 miles. With few exceptions these palms receive no cultivation or irri-

gation except that given to other crops grown with them. There is very little export of dates.

"HATIYA" OR ABANDONED PLANTINGS

In addition to the 5 million palms in Libya mentioned above, there are several million more, difficult to estimate because they have the appearance of natural growth along the "wadis" (dry, desert watercourses) or where because of geological formations some subterranean moisture is available. In most cases there is no dominant stem; instead all the competing offshoots form large clumps, 10 to 20 feet high to the leaf tips and sometimes called "bush palms." There may be 50 to 100 or more stems in a single clump, offshoots no doubt from several different palms. It is thought by some that these palms that appear as natural growth, sometimes called "hati-ya," represent palms planted, but long ago abandoned and never cultivated. USOM has recently initiated a project to remove about 90 percent of the stems of some of these bush palms so that those retained will improve in growth and bear some fruit.

Around the desert oases there are also large number of palms that obviously were once part of cultivated plantings but have received no irrigation in recent years because no other crops are grown among them. Most of these abandoned palms, including even those along the wadis, can be identified as varieties. This indicates that they were planted as offshoots and is evidence that date culture has declined in the Fezzan during the last century (7). However, these uncultivated palms may be regarded as a semi-natural resource serving in lieu of the forests of more humid climates. The inhabitants make use of date palms not only for fruit but also for building materials for

their houses, furniture, and articles of many kinds, as well as for firewood. Many of the palms receive enough subterranean moisture to permit some growth and, if pollinated, the production of small crops of fruit. Furthermore, both sap and bud, although seldom taken from date palms valued for fruit production, are relished additions to the diet of the inhabitants. Thus all the palms are a potential source of good and valuable material when other sources are restricted by war or national emergency.

PALM SPACING ALONG THE COAST

The spacing of date palms along the coast of Tunisia and Libya affords an interesting example of adaptation to particular conditions. The climate is distinctly marginal for date culture; the average temperature is lower than in the interior desert; the relative humidity is high; and rain occurs with increasing frequency in the fall. Only early-ripening varieties can be grown and even these are often damaged by rain before the end of the harvest. Nevertheless dates are an important crop.

At Gabes in Tunisia palms are regularly planted 10 to 15 feet apart in one or two rows around open centers of varying size, usually less than an acre (5). Along the Libyan coast palms are widely spaced, 30 to 40 feet within rows running north and south and separated by as much as 60 to 100 feet or more. In the open centers and between the rows are grown other crops of local importance—vegetables, some fruit trees, and, especially in Libya, cereals. This arrangement affords light and aeration on the sides of the palms and reduces damage from high humidity; at the same time the intercrops also receive their share of sunlight without extremes and are afforded some protection from hot dry winds from the interior desert.

DATE HARVEST IN TUNISIA

I visited Tunisia in time to see the harvesting of fruit of the two principal varieties, Deglet Noor and Fteemy (also known as Alligue). I was surprised to hear the complaint that rain damage has occurred several times during the last decade, more, it was said, than in the Oued Rhir of southern Algeria only about 100 miles to the west. I did not see any rain damage around Nefta and Tozeur, where some of Deglet Noor fruit was of exceptionally fine quality, but at Gafsa, near the foothills about 40 miles northeast, I found rain damage on fruit of both Deglet Noor and Fteemy.

Gafsa is higher and slightly cooler than Nefta and Tozeur, enough so that Deglet Noor dates do not ripen

well. Dr. P. Crossa-Raynaud plant breeder for the Tunisian Government, knew of the experiments in California which have shown that the ripening of dates may often be advanced as much as 2 weeks or even more by the use of certain pollens, and it was his interest in the possibility of making beneficial use of this effect of pollen (metaxenia) that led to the request for my visit to Tunisia. I had two conferences with Dr. Crossa and some pollination tests are being planned to see whether the ripening of dates at Gafsa can be speeded up in this way. At Gabes on the coast some 200,000 palms grow in a climate with less heat, more rain and higher humidity than at Gafsa and here an acceleration of ripening would be even more beneficial.

PROGRESS IN TUNISIA

At Semchi, near Tozeur, I had an opportunity to see one of several projects undertaken to provide landless farmers with small holdings. Here the cultivation of new land was made possible by an artesian well that provides water enough for 60 blocks of 1½ hectares (3 acres) each. In each block dates have been planted, 80% to the Deglet Noor variety, and 20% to the Fteemy. The offshoots had been out only one season but were off to a good start with 100% survival in many blocks.

There was evidence of other improvements in this area. The flow of springs had been increased by cleaning and enlarging and some of the main canals and irrigation ditches were being cemented. I was told that the Tunisian Government is setting up a program to reduce the number of palms of inferior varieties and increase the spacing between good ones. There are plans for two new packing houses and three date storage sheds. The officials that I met in southern Tunisia had an alert and progressive attitude that could mean much future improvement in the date industry.

VARIETIES

The varieties grown in Libya could not be evaluated on such a short visit after the date harvest. I saw only a few samples of the fruit of some of them. Because of fall rains and relatively low temperatures the fruit produced along the coast is of inferior quality, adapted only to local use or by-products. Yet, about half of all the fruit production in Libya is in this zone (2), and most of it is one variety, Bikraari. However, the palms along the coast are planted as much for the protection they afford to other crops as for the fruit they produce.

In the interior the climate is favorable for date culture and there are some excellent varieties, such Halima and Khadhrai (not the Khadrawy of Iraq, but a variety with somewhat

similar fruit). However, such a large proportion of the palms is neglected or receives only the minimum of care that the proportion of high grade fruit is very low. Several times I had an opportunity to see the difference between fruit of the same variety produced on palms that had had little or no care and on palms that received irrigation and some fertilization because of the intercrops grown with them. The fruit is often hardly recognizable as the same variety. I am sure that if the fruit of any variety is to be sold successfully in export markets, the palms will have to be given better care, particularly more water, than most of them now receive.

DEGLET NOOR

One of the reasons the Libyan Government asked me to visit their date area was to get an opinion on the possibility of growing the Deglet Noor variety successfully and on the localities where it is likely to do best. There are already a very few specimens at two places—Ghadames on the western border, where Tunisia and Sahara meet, and Hon in the north central part of the interior desert. I had an opportunity to see Deglet Noor palms at both places. They were growing as well as other palms around them but had a heavier than average infestation of *Parlatoria* date scale (*Parlatoria blanchardi* [Targ]). The fruit had all been harvested, but I saw a few samples that the owners had saved. The fruit was small, as would be expected without thinning, but some was of good quality. It was reported, however, that a large proportion of the crop was dry and that there had been considerable damage from date mite (*Paratetranychus afra-siaticus* McGregor).

Damage from both *Parlatoria* date scale and date mite is likely to be severe, for the Deglet Noor is more susceptible to attacks of both pests than many other varieties and such damage is apparently increased by high temperatures and low humidity. From a few climatic data available, the temperatures at Ghadames and in most of the Fezzan are a little too high, especially in April and May, for the best production of Deglet Noor fruit. The percentage of dry fruit will probably be high in most years. Furthermore, fruit production of the Deglet Noor variety will not be satisfactory if the palms receive only incidental irrigation and cultivation resulting from the care of other crops grown with them, as is characteristic of nearly all date culture in Libya.

OTHER PESTS AND DISEASES

In the Oases of Marada and Jikhara I saw some palms, mostly of the Saidy variety, which had been damaged by a borer. What is appar-

ently the larva of some beetle bores into the midrib anywhere along the blade of the leaf and so weakens it that it breaks off. Many of the palms had a ragged appearance and were estimated to have lost about half of their green leaf area. Although a number of damaged leaves were examined none of the borers were found.

Graphiola leaf spot (*Graphiola phoenicis* [Moug.] Poit.) occurs on palms along the coast, but I found very little of it, no serious infections, and no evidence of much damage. The low incidence of graphiola leaf spot is probably explained primarily by the wide spacing of palms along the coast and the frequent occurrence of hot dry winds from the interior, but may be due in part to some degree of resistance in the varieties grown (6).

I saw no blacknose or serious checking on Deglet Noor fruit in either Tunisia or Libya. It is evident that in the desert portions of these countries there is seldom enough humidity during the latter part of the summer to cause such trouble.

FRUIT STORAGE IN SAND

In the Fezzan, dates are stored in very crude and primitive fashion by merely burying them in sand. A hole about 4 feet in depth and width is dug, filled with dates to within about a foot of the ground level and then covered with sand. The practice has some merit for sand is a good insulator and there is seldom enough rain to penetrate to the fruit, but all the dates are in contact with sand, some of which becomes incorporated with the flesh and can never be removed. The fruit is not stored in this way until it is quite dry.

BUNCH MANAGEMENT

Along the coast of Libya the fruit bunches are pulled down through the leaves, but instead of attaching the fruitstalk to a midrib, as in California, it is bent in an inverted U-shape and held in place by a strip of fiber torn from the side of the fruitstalk itself. This strip of fiber is left attached to the fruitstalk at the base, but the

outer and free end is tied to the fruitstalk at the point where the strands begin to branch. Tying in this way seems to strengthen the fruitstalk and places the bunch nearer the trunk where it can be reached more easily in harvesting. Incidentally, fruit of some varieties, such as Beiyuudhi and Taabuuni, is generally picked by hand, whereas that of the most common variety, Bikraari, is generally harvested by cutting the bunches as is the almost universal practice elsewhere.

ECONOMIC CONDITIONS

The economic condition of the Libyan date industry has been declining in recent years. The decline may have begun when automotive transportation began to displace the camel caravans, for many of the routes were abandoned and some of the remote desert oases, such as those in the Fezzan, decreased in importance. Some of the inhabitants of the oases have sought better conditions elsewhere. For a long time the supply of labor in the date gardens has been decreasing. This is being accentuated by the oil boom. Drilling for oil is going on all over Libya and manual laborers are recruited locally. Very few people were seen at work in the date gardens and nearly all were old men. The shortage of labor has resulted in many operations being neglected or not being done as well as they should be. For example, I was told that in some places, instead of individual flower clusters being pollinated, as is the usual and desirable method, the laborer climbed the palm once to place a male inflorescence in the center of the crown and left the pollination of individual clusters to the wind. An increasing number of date gardens are being abandoned.

Before World War II there was some export of dates, sometimes as much as 11 million pounds annually, to Italy (2). Since the war export has been negligible. Furthermore, with the increase in transportation facilities throughout the world and the increased availability of other foods, the internal demand for dates has declined.

However, the trend may change soon. The recent discovery of oil in Libya is already bringing more money into the country. Construction has been started on a paved road that will connect Sebha, the capital of Fezzan, with the coast. Better transportation should improve conditions in that region. If the increasing revenues from oil are used for the welfare of the country the entire economy should be benefited. Perhaps now it will be possible to initiate the research and extension work that must precede any permanent improvement in date culture or any other agricultural industry (2).

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